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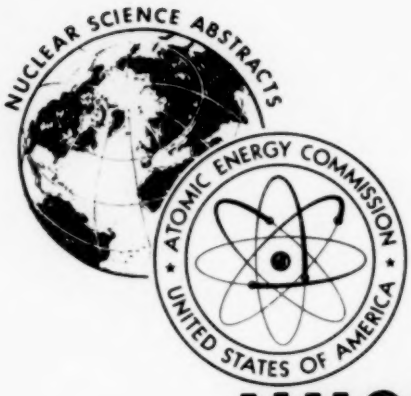

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NUCLEAR SCIENCE ABSTRACTS

Volume 17 Number 2

Abstracts 1165 – 2655

January 31, 1963

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Use of funds for printing this publication has been approved by the Bureau of the Budget, July 29, 1960.

Volume 17, Number 2 January 31, 1963

NUCLEAR SCIENCE ABSTRACTS

GENERAL AND MISCELLANEOUS

1165 (AD-273825) THE DETECTION AND INDENTIFICATION OF UNDERGROUND NUCLEAR EXPLOSIONS: A STUDY. George L. Turin (Massachusetts Inst. of Tech., Lexington. Lincoln Lab.). Mar. 2, 1962. Contract AF19(604)-7400. 32p.

An investigation was made concerning the problems involved in the detection and identification of underground nuclear explosions. A brief summary of the history of recent interest in the problem is given. A discussion of phenomena associated with an underground explosion is presented. Of these phenomena, two are discussed in detail: low-frequency electromagnetic disturbances and seismic disturbances. Some of the pertinent facts of seismology and various possible seismic methods of detecting underground explosions and distinguishing them from earthquakes are presented in detail. (auth)

1166 (ANL-6624) ARGONNE NATIONAL LABORATORY PUBLICATIONS, JULY 1, 1961—JUNE 30, 1962. (Argonne National Lab., Ill.). Oct. 1962. Contract W-31-109-eng-38. 201p.

A publications list, incorporating a subject index was compiled by machine methods. The publications covered are those originating at Argonne but published elsewhere. The list is arranged alphabetically by author's names and covers the period from July 1, 1961 through June 30, 1962. The subject index is a key word in context index using the title. (M.C.G.)

1167 (LADC-5489) SATELLITE-BASED DETECTION OF NUCLEAR DETONATIONS IN SPACE. Richard F. Taschek (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract [W-7405-eng-36]. 9p.

Detection of the detonation of nuclear bombs in space, at distances where difficulties are experienced in conventional ground-based detection, by using satellite-based detection is described. Orbital considerations and parameters are discussed. Detectors for neutrons, gamma rays, and x rays are described and their arrangement on the satellite discussed. (M.C.G.)

1168 (SC-4675(RR)) 20-TON AND ½-TON HIGH EXPLOSIVE CRATERING EXPERIMENTS IN BASALT ROCK. Final Report, August 1962. E. E. Anderson, R. A. Berdinelli, R. H. Bishop, R. J. Burton, A. J. Chabai, D. G. Palmer, J. W. Reed, and L. J. Vortman—D. F. Rauber, ed. (Sandia Corp., Albuquerque, N. Mex.). PROJECT BUCKBOARD. Contract [AT(29-1)-789]. 308p.

Project Buckboard consisted of the detonation of ten 1,000-pound charges and three 40,000-pound charges in basalt rock. One-thousand-pound spheres of cast TNT and blocks of cast TNT stacked to resemble 40,000-pound spheres were center detonated. The 1,000-pound charges were burst, two each, at depths of 5, 10, 15, 20, and 25 feet. The 40,000-pound charges were buried at depths of 25.7, 42.75, and 59.85 feet to the charge center. One 1,000-pound charge, placed at 25 feet, was a cylinder with a length-to-diameter ratio of two. It was placed with the long axis vertical. This charge was detonated to determine if there were detectable differences in crater dimensions attributable to charge shape. The basalt rock had a density greater than 2.6 gm/cm^3 and a compressive strength close to or above 20,000 pounds per square inch. The first 12 to 15 feet of basalt was usually highly vesiculated, and hence in this region density and compressive strength were less than the values listed above. The scatter in crater dimensions made it impossible to determine whether or not departures from cube-root scaling existed. Ground surface displacement as a function of time was determined from motion picture photography. Contributions of both the ground shock wave and the motion induced by pressures of the explosion gases were clearly distinguishable. Empirical relationships for peak shock-induced velocity in basalt are compared with comparable results from shots in desert alluvium and in tuff. Shock-induced vertical acceleration and gas-pressure-induced acceleration are also compared with similar results from 40,000-pound charges in alluvium. Fine particulate or dust ejected by the explosion was collected at eight distances along 12 radii. An empirical relationship was developed for giving the mass of fine particulate as a function of the volume of the apparent crater. The mass of fall-back coming from a Buckboard explosion compares within a factor of two with the mass of fall-back from comparable Stagecoach detonations. Measurements of ground motion and pressure were attempted on Shot 12. Measurements tried included acceleration, velocity, stress, and strain along a horizontal radius at the burial depth of the charge. Information was obtained from ten of twenty-two attempted measurements. In the remaining channels there were either serious system failures before signal arrival or else set ranges were much too high for the weak signals transmitted. Measured and calculated values of peak stress differ by a factor of two. If the difference can be attributed to a discrepancy in calibration constants, then the data obtained from surface velocity and from stress measurements are consistent. Vertical displacements of the dust clouds, including earth mound, smoke crown, column, and jetting material, were determined from motion picture photography. Hori-

zontal dimensions of the base surge, cloud, column, and the jets were also determined. Vertical velocity as a function of time was obtained from the displacements. These observations were limited to the 40,000-pound charges. The two shallower shots show a definite contribution to the sustainment of the velocity by the emergence of jetting material. Venting times, compared with those in alluvium and tuff, are presented in the form of relationships for burst depth as a function of venting time. Plots of the log of scaled burst depth against scaled time of jet breakthrough show a linear relationship for both basalt and alluvium, with different slopes but with the same intercept at zero time. There was no well defined column on the deepest Buckboard shot. At corresponding times, the column heights in basalt are greater than those in alluvium. Differences in the growth of the base surge to the left and right of the camera line-of-sight on Shot 12 cannot be attributed to winds because of low velocities existing at shot time. The most rapid growth occurred on the side of the crater which was excavated in solid basalt; the other half was in cinders. Close-in air blast was measured along the ground surface on each of the three 40,000-pound charges. The major overpressure contribution came from the venting of explosive gases. There were no significant differences between the overpressures from these gases from charges at corresponding depths in basalt and alluvium over the range of ground surface distances at which overpressures were measured. A perturbation exists in the plot of impulse versus burst depth at a scaled burst depth of about 1.25. Were this not precisely verified by the results of Project Scooter, the value would seem anomalous. The results indicate no reason to depart from the use of cube-root scaling for blast phenomena, even though such departures are observed in the scaling of crater dimensions. The ground-shock-induced air shock is suppressed more by shots deeper than 1 ft/lb$^{\frac{1}{3}}$ in alluvium than in basalt. At shallower burst depths, the suppression is less for charges fired in alluvium than for those fired in basalt. The maximum ranges of rock ejecta were determined on several of the shots. Initial velocities calculated by using an assumed initial angle of 45 degrees and the terminal position of the rock are consistent with initial velocities from motion picture records. The maximum range for TNT explosions in rock at a scaled burst depth of 0.75 ft/lb$^{\frac{1}{3}}$ is found to be nearly 10,000 feet. Distant air blast pressures from the three 40,000-pound shots were measured to determine the amount of distant blast suppression caused by charge burial in hard rock. At on-site distances greater than 1 mile, overpressures from charges in basalt appear to be suppressed less by charge burial than corresponding charges in NTS desert alluvium. At off-site distances (100 to 150 miles) the difference between blast suppression in basalt and alluvium appears to be smaller. Description of site location and preparation, excavation and loading of charge cavities, safety and firing procedures, together with details of the engineering of the experiments, is provided. Methods of stemming the charge holes with reinforced concrete, in some cases keyed to the basalt, are described. For the three 40,000-pound charges, the concrete stemming was color-coded so that post-shot location of pieces of colored concrete would provide some indication of the trajectory of stemming material as a function of depth of stemming. (auth)

1169 (SC-4735(RR)) A SCALE-MODEL EXPERIMENT OF THE CRATER PRODUCED THROUGH TERRAIN OF RANDOMLY VARYING ELEVATION BY ROW CHARGES. A Contribution to the Plowshare Program. L. J. Vortman (Sandia Corp., Albuquerque, N. Mex.). Nov. 1962. Contract [AT(29-1)-789]. 27p.

A scale-model experiment was made to check the application of charge spacing rules developed from earlier studies to terrain of randomly varying elevation. Since a prominent possible peacetime use of nuclear explosives is the excavation of a trans-Isthmian canal, the model used was a portion of such a route. The experiment resulted in nearly the desired linear crater dimensions; the spacing rules developed for level terrain give a satisfactory channel when applied to terrain with elevations varying in a random fashion. (auth)

1170 PEACEFUL USES OF NUCLEAR EXPLOSIONS. E. W. Carpenter (Atomic Weapons Research Establishment, Foulness, Southend-on-Sea, Eng.). Research (London), 15: 446-52(Nov. 1962).

A review is given on experiments which are being carried out, planned, or proposed for the peaceful uses of nuclear explosions under the aegis of Operation Plowshare. Special attention is given to underground explosions. The projects discussed include phenomenology, mining applications, excavation and earth moving, power generation, and safety. (P.C.H.)

1171 PRINCIPLES OF RADIOISOTOPE METHODOLOGY. Second Edition. Grafton D. Chase and Joseph L. Rabinowitz. Minneapolis, Burgess Publishing Co., 1962. 384p. $6.00.

This book is essentially a laboratory manual, giving methods of procedure, for the beginner in the field of radioisotopes. It is intended as an introductory guide for the technician, medical student, or researcher who may find radioisotopes valuable in his work. Among the topics treated are radiation detection and measurement, radioactive decay, nuclear analysis, radiochemical separations, and application of radioisotopes in chemistry and the biological sciences. (D.L.C.)

1172 ENGINEERING SCIENCE — A BASIS FOR GRADUATE STUDY IN NUCLEAR ENGINEERING. (Purdue Univ., Lafayette, Ind.). [1962]. Contract [AT(11-1)-122]. 7p. (TID-17068)

To be published in TID-7638, Proceedings of the Symposium on Progress in Nuclear Education, held in Gatlinburg, Tennessee, August 20-22, 1962.

Organization for training nuclear engineers is discussed. It is pointed out that nuclear engineering must become a part of each of the other engineering departments in colleges and universities. Difficulties of building such relations are examined. It is suggested that a sort of partnership between undergraduate engineering science and graduate nuclear engineering be formed which leaves the traditional departments intact to continue their former activities but requires that they meet the new requirements. (J.R.D.)

BIOLOGY AND MEDICINE

General and Miscellaneous

1173 (HW-70050) RESEARCH AND DEVELOPMENT ACTIVITIES IN THE RADIOLOGICAL SCIENCES. Physical Sciences Portion, January–December 1960. R. L. Junkins and P. F. Ashbrook, eds. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 16, 1961. Contract AT(45-1)-1350. 293p.

Separate abstracts were prepared for 5 sections of this report. Research activities are reported in the fields of atmospheric diffusion and transport, whole-body counting, analytical and counting methods for radiological chemistry, special geological and hydrological studies related to effluents research, and the development of radiation monitors, dosimeters, and special purpose instruments. (C.H.)

1174 (HW-70050(p.12-30)) ATMOSPHERIC PHYSICS. J. J. Fuquay, P. W. Nickola, et al. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Micrometeorological research was continued in problems associated with predicting the levels of dosages and concentrations in the environment due to the release of contaminated materials to the atmosphere. Data collected during a series of field experiments on the diffusion and deposition of air-borne materials, using quantitative tracer techniques, were analyzed for diffusion characteristics according to the Gaussian model. Results compared favorably with those obtained earlier from photographic studies of oil fog diffusion. A procedure is described that was developed for the assay of field samples of zinc sulfide fluorescent pigment used as a tracer material in studies of dispersion and deposition in the lower atmosphere. Instrumentation was developed and calibrated for activation and counting the scintillations from the zinc sulfide with a liquid scintillation spectrometer. The procedure was used successfully for assaying some 35,000 field samples collected during diffusion experiments. Data from a total of 28 field experiments on atmospheric dispersion during a variety of meteorological conditions were analyzed within the framework of a Gaussian formula. Results of the area-dosage analysis are summarized and discussed. (C.H.)

1175 (HW-70050(p.31-77)) RADIOLOGICAL PHYSICS. W. C. Roesch, H. E. Palmer, et al. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Normal individuals were analyzed by whole-body counting for radioactivity from K^{42}, Cs^{137}, Zn^{65}, Na^{24}, and Ta^{182}. Counting methods, shielding, and factors affecting results are discussed. Design features are described of a polyethylene long counter for measuring fast neutron flux. Data are also included from an investigation of the effect of source size on the neutron energy spectrum from radioactive neutron sources. A double moderator neutron detector was used for the measurements. Data are tabulated for several different sizes of Ra–Be, Po–Be, and Pu–Be sources. Calibration of the Perlow neutron spectrometer, a proton recoil telescope utilizing a gaseous radiator, is described. A high-current r-f helium ion source and a variety of targets were developed for the Van de Graaff accelerator. A total absorption calorimeter was used for precision measurements of γ activity from a Co^{60} and 2 half-gram radium sources. Procedures are described and data on the 3 sources are tabulated. An apparatus is described for use in measurement of the stopping power of Al foil for 1-Mev electrons. Instrumentation and facilities are described briefly that were developed for use with the 2-Mev Van de Graaff accelerator, a method is described for linearizing thermistor thermometer data in calorimetry, and a liquid nitrogen level controller is described. (C.H.)

1176 (HW-70050(p.78-142)) RADIOLOGICAL CHEMISTRY. R. W. Perkins, C. W. Thomas, et al. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A radiochemical procedure is described for the measurement of Np^{237} in urine samples. Preliminary results are given from an investigation of the use of electrodialysis using ion exchange resin in a sheet form in the analysis of low level wastes. A sketch is included of an electrodialytic cell that incorporates a membrane sheet. Results of runs using Sr^{85}-spiked tap water, reactor effluent water, and Columbia River water indicate that electrodialysis can be used advantageously in concentrating samples of large volumes and that cell design is extremely critical. Procedures are described for the separation of radioactive Zn from reactor cooling water by isotope exchange with inert Zn in the form of Zn amalgam, for the determination of Sr^{90} in samples of milk, for the determination of Sr^{90} in samples of urine, and for the detection of trace amounts of radioactivity in chemical reagents or other materials. The use of anticoincidence shielding in gamma ray spectrometry was found to produce a significant reduction in the background counting rate. Shielding materials, background measurements, detector-sample arrangements, and the design and performance of two total absorption γ ray spectrometers utilizing anticoincidence shielding are described. Analytical techniques were developed for the quantitative measurement on the same sample of two tracers, zinc sulfide and fluorescein, to be used for atmospheric dispersion experiments. Automatic counting equipment was developed for the quantitative measurement of zinc sulfide by electronic counting of phosphorescence emission. The concentration of a comprehensive spectrum of radionuclides and the rare earths group in Willapa Bay oysters was measured and data are tabulated. Reactor studies reported include the production of high-purity Np^{239} by resonance neutron activation of depleted U, determination of the cross section for the threshold reaction $S^{32}(n,p)P^{32}$, thermal and fission neutron flux measurements in process tubing and in neutron activation test locations, investigations on the source of P^{32} and Sc^{46} and the chemical forms of radioactive ions in Hanford reactor effluent, radioisotope concentrations in effluent water from a Zircaloy-2 process tube, and the effectiveness of high coagulant feed on the reduction of reactor effluent radioisotope concentrations. Measurements were made of the radiation sensitivities of a number of metabolic products in dilute aqueous solution. Values were determined for the relative rate constants of some reactions between radicals formed in irradiated water and metabolities found in living tissues. Data are tabulated. Comparisons were made between radiation protection index and the chemical structure of some metabolites. The most reactive amino acids were those containing aromatic rings or sulfur, followed in order of their decreasing reactivity by the branched-chain aliphatic members and the straight-chain aliphatic amino acids. Aqueous solutions of erioglaucine bleach were found to be approximately 4 times as sensitive as the conventional ferrous sulfate radiation dosimeter. Results are

reported from preliminary studies on the radiation chemistry of agar. Protolysis and hydrolysis constants were determined for several trisulfonated triphenylmethane dyes of interest as radiation dosimeters and protective agents in biological systems. Data are tabulated for erioglaucine, brilliant acid green 6-B, and light green SF yellowish. Progress is reported in the development of a membrane electrode cell for the determination of dissolved oxygen concentration of small samples with high sensitivity. (C.H.)

1177 (HW-70050(p.143-219)) CHEMICAL EFFLUENTS TECHNOLOGY. R. E. Brown, D. J. Brown, et al. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Results are reported from a series of studies on the special geological features of the Hanford Area that affect the three-dimensional flow of ground water and related studies of interest in the monitoring of ground water for radioactive contaminants and the storage and disposal of wastes at depth. The geology of the area was characterized in such a manner that mathematical models may be used in calculations of macroscopic flow in porous media as induced by mechanical potentials. Adequate numerical techniques and an associated computer program were devised to solve the class of nonlinear partial differential equations required. A laboratory flow system was devised to permit the simultaneous addition of two liquids of different densities so that they flow one above the other into a bed of 3-mm glass beads. The system was designed for use in studies of waste disposal to a ground aquifer. A diagram is presented of a laboratory vertical flow system designed for use in obtaining data for use in developing an equation for unsaturated flow based on the Darcy equation and an analogy of the Poiseuille equation. Data are tabulated on flow rates at various moisture contents and hydraulic gradients for various sand and soil samples. Comparisons are presented of theoretical and experimental analysis of partially saturated flow. Finite difference techniques applied through a computer program were used for solution of the nonlinear equations. A technique using electrical analogs was developed for in-place measurement of permeability in heterogeneous media for use in ground-water studies of the Hanford region. Several zeolites were examined for their ability to effectively remove Ce from solutions containing large amounts of competing cations. Schematic sketches are presented of a constant temperature apparatus designed to study the column behavior of zeolite adsorbers and an apparatus used to obtain zeolite loading curves. Results are tabulated for some of the experiments. Studies were continued on the nature of cation substitutions during formation of phosphorite from calcite. Data are presented from a statistical treatment of substitution data for the radioisotopes of Pm^{+3}, Sr^{+2}, U(VI), and Pu(IV) in apatite which forms during alteration of calcite by alkaline, phosphate-bearing solutions. An investigation was also made of the general principles governing anion replacement reactions and their relationship to concomitant cation incorporation in the final replacement product. Data are tabulated for some experimental mineral columns in which the final products were identified by their x-ray diffraction patterns. Replacement reactions were evaluated for possible application to the decontamination of solutions by the incorporation of radioactive cations in the solid product. The fixation of Sr by substitution of Sr^{+2} for Ca^{+2} is cited as an example. Data are included from studies on the effects of rare earth oxidation state and the nature of the reactions involved in rare earth uptake by soil. The effect of accompanying ions on the retention of radiostrontium in soil columns and the adsorption of Sr by soils under saturated and unsaturated flow conditions were studied. A field test was instituted to examine the capacity of the soil beneath a crib for the absorption of radioisotopes. Wells were driven into the water table at various points around the cribs and ground water samples were analyzed for nitrate ion and Sr^{85}. Equipment development is reported for use in studies on the deposition of particulate matter in sampling lines, for multiple sampling of wells, for vertical well sampling, for measurement of soil water, and for use in monitoring noble gas isotopes as an index to radiologically significant fission products in reactor effluent cooling water. Results are reported from a series of studies to determine the effect of irradiation on the release of fission products from U heated in air and the quantity and size distribution of particulate material formed during the oxidation of U. (C.H.)

1178 (HW-70050(p.220-88)) INSTRUMENTATION. M. O. Rankin, D. P. Brown, et al. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

Design features and electronic circuits are described for a semiportable particulate monitor for mixed fission products in air. A miniature β scintillation detector was developed and tested for various nuclides in solutions. Instruments were developed for whole-body monitoring of radioactivity and measuring biological parameters of radioisotopes in small animals and fish. The development is reported of a pocket radiation dosimeter with preset alarm, thermoluminescent finger ring dosimeters for measuring hand dose to handlers of Pu metal, a miniature thermoluminescent detector for measuring internally deposited radionuclides, a small dose-rate integrating dosimeter, a solid-state surface barrier silicon crystal detector, large and small α and β survey probes of the scintillation type, and line-operated transistorized radiation detection instruments for use as general α-β-γ monitors. Photographs and electronic circuits are included for an aural alpha-beta-gamma monitor, a scintillation plus air-proportional alpha monitor, and a Scintran monitor adapted to serve as a neutron dosimeter. Development and prototype fabrication is reported for two types of β-γ building radiation monitors and one personnel monitor. A diagram is included of a proposed radio telemetering system considered as a possible method of obtaining current, accurate accumulated dose information for personnel working in reactor buildings. Progress is reported in a robot monitoring study in which robot principles will be applied to the measurement of radiation fields and contamination levels under conditions where humans cannot perform tasks. Special purpose instruments developed include high-level monitors for cells and filters, an automatic laundry monitor, a mechanical γ scanning unit, circuits of an electron accelerator, a monitor for mixed fission products on face masks, and an automatic particle counter for fluorescent zinc sulfide particles. (C.H.)

1179 (IA-767) A QUANTITATIVE DETERMINATION OF THE RATE OF THYROXINE DEIODINATION IN HUMANS. M. Anbar, S. Guttmann, G. Rodan, and J. A. Stein (Israel. Atomic Energy Commission, Rehovoth). Aug. 1962. 13p.

Thyroxine labelled with I^{131} was injected into patients, followed by an injection of iodide-132 after 48 hr. The activities of both isotopes in blood and urine, and the I^{132} uptake in the thyroid gland were measured for 8 to 10 hours following the iodide-132 administration. The steady state concentration of iodide-131 in serum was determined from the ratio of activities of I^{131}/I^{132} in urine and the iodide I^{132}

activity in serum. The rates of iodide clearance were determined by means of iodide–132 using conventional methods. From these determinations it was possible to calculate the rate of deiodination of thyroxine in humans. (auth)

1180 THE USE OF I^{125} LABELED DIIODOFLUORESCEIN IN THE DETECTION OF HUMAN INTRAOCULAR NEOPLASMS. Seymour B. Goren, Frank W. Newell, Herbert E. Brizel, and Paul V. Harper (Univ. of Chicago). Am. J. Ophthalmol., 54: 191-6(Aug. 1962).

The new method which is described is believed to be superior to the usual method for detection of intraocular tumors using P^{32}. Because of the limited penetration of beta rays, the use of P^{32} imposes relatively strict geometric restrictions and its usefulness in posterior-segment tumors is limited. The patient receives a single intravenous injection of 5.0 $\mu c/kg$ body weight of diiodofluorescein-I^{125}, the specific activity of which is 17 mg/mc. External counting over each closed eye is carried out with a hand scintillation counter 1, 5, 8, and 24 hr after injection. Ocular counts are performed by resting the window of the counter against the closed lids; the cavernous sinus is measured by placing the counter just above the bridge of the nose. In the 17 patients studied, eyes with neoplasms contained at least 23% more radioactivity after 8 hr than did the healthy eye. Control eyes, not containing neoplasms (idiopathic retinal detachment, retinoschisis, benign nevus, macular degeneration, phthisis bulbi, absolute glaucoma), showed less than a 13% differential. One false negative test was obtained, a patient with a metastatic bronchogenic adenocarcinoma to the choroid; no false positives were seen. Diiodofluorescein labeled with I^{131} has been widely used as a diagnostic aid in suspected intracranial neoplasms. However, since the gamma rays of I^{131} have a half-value layer in tissue of 6.9 cm, it has not been helpful in ocular disease; the gamma rays arising from the cavernous sinus interfere with accurate counting of intraocular radiation. I^{125} decays by a complicated scheme, the most important as far as ocular studies are concerned being soft photons of 27.3 and 35.4 kev energies. It has a half-value layer in tissue of 1.9 to 2.5 cm. Therefore, it is feasible to measure radiation of the posterior globe with only minimal interference from radiation arising in the brain sinuses. Its half-life of 60 days results in a greatly increased shelf-life of tagged compounds than when I^{131} is used. Additionally, it has a lower energy of radiation than I^{131} which reduces shielding requirements and permits more efficient detector design. These factors permit enhanced counting efficiency and scanning resolution and lead to a decreased dosage of radiation to the patient. It is thus permissible to use the compound in children in whom P^{32} counting is generally considered contraindicated. However, although the total-body irradiation received during this test is not excessive, it has not been used in pregnant women. The administration of Lugol's solution prior to the test prevents excessive concentration of any free circulating radioactive iodine in the thyroid gland. Diiodofluorescein-I^{125} is not retained by intraocular neoplasms for prolonged periods of time, the most significant counts appearing 8 hr after intravenous injection. About 50% of the injected dose is excreted in the urine and feces within the first 24 hr after injection. The absolute count found in the eye after 8 hr is in the order of 40,000 cpm. After 24 hr, this decreases to ~15,000 cpm. The ratio of counts over liver, thyroid, eye, and cavernous sinus is about 4:2:1:0.4. The ratio of counts between the 2 eyes is more significant than the absolute number of counts. This may limit the usefulness of this procedure in monocular patients. (H.H.D.)

1181 SIMPLE TECHNIQUE FOR THE DETERMINATION OF INTRATHORACIC DOSES RECEIVED FROM COBALT-60 IRRADIATION (CYCLOTHERAPY AND FIXED OPPOSING FIELDS). André Chevallier and Jean Herdly (Faculté de Médecine, Strasbourg). Ann. Radiol., 5: 435-46(1962). (In French)

A simple technique for measuring the intrathoracic dose received in Co^{60} irradiation is described. The technique is based on the use of a NaI scintillation counter, regulated to register only the single wave length of Co^{60}. By elimination of the scattered radiation, the absorption in a given direction can be measured. The absorption value expressed as a water equivalent takes into account the variable amounts of air contained in the lung field. It permits exact calculation of the doses received both during rotation therapy in the region of the rotation center and during fixed field therapy under certain well-defined conditions. The technique also enables the observer to follow changes in radiation absorption by mediastinal tumors during treatment. (auth)

1182 PHYSICOCHEMICAL STUDIES OF ULTRAVIOLET-IRRADIATED BOVINE SERUM ALBUMINS. George Kaldor, Abraham Saifer, and Francis Westley (Jewish Chronic Disease Hospital, Brooklyn). Arch. Biochem. Biophys., 99: 275-81(Nov. 1962).

Experiments performed with bovine serum albumin (BSA) had its modified derivatives over a wide pH range, have shown the lack of correlation between the aggregation and absorbancy increase effects produced by ultraviolet (UV) irradiation. The aggregation effect was found to be governed mainly by the over-all charge on BSA or its derivatives with the exception of iodinated BSA which showed marked resistance to aggregation over the entire pH range. The influence of over-all protein charge on the aggregation effect produced by UV irradiation was further confirmed by studies with BSA-detergent complexes. Prior addition of Zephiran enhanced, sodium dodecyl sulfate and caprylate inhibited, and Tween 80 was without effect with reward to aggregate formation with UV light. Modification of tyrosyl side chains, e.g., iodinated or diazotized BSA, changed the UV absorbancy increase pattern of BSA in the acidic pH range at wavelengths < 3000 A. Modification of the amino group, e.g., acetylated or guanidylated BSA, changed the absorbancy increase pattern of BSA in the alkaline range usually at wavelengths above 3000 A. Methylation of carboxyl groups (MeBSA) produced little or no change in the UV absorbancy increase spectra. Changes in the absorbancy increase may be attributed either to modification of the tyrosyl side chains or to changes in hydrogen bonding between amino and tyrosyl groups. (auth)

1183 RADIOACTIVE MATERIAL IN THE BODY. DETECTION AND TREATMENT. W. Daggett Norwood (General Electric Co., Richland, Wash.). Arch. Environ. Health, 5: 167-72(Aug. 1962). (HW-SA-2278)

The hazards, identification, and removal of radionuclides that have gained entrance to the body are discussed. Such material may enter the body by inhalation, ingestion, or through a break in the skin. Early diagnosis depends upon an environmental analysis and more directly upon measurements of the radiation from the deposits within the body or in excretions. The hazard from such deposits depends upon such factors as (a) amount and site of deposition in organs, (b) half-life of its radiation and time of retention in the critical organ, (c) type and energy of radiation emitted, (d) essentiality of the organs effected, and (e) sensitivity of the critical organ or tissue to radiation. Surface contamination may usually be removed by washing with water and detergent. Traumatically embedded radioisotopes may re-

quire surgical removal. Decontamination of the gastrointestinal tract is similar to that used for inactive chemical poisons which are swallowed. There is no effective method for increasing the elimination of insoluble isotopes from the lungs. DTPA (diethylenetriamine pentaacetic acid), a newly developed chelating agent, appears promising in increasing the elimination of plutonium from the body via the urine, and it may be similarly useful in increasing the elimination of other transuranium elements and fission products with the exception of Sr. Elimination of H_2^3O may be markedly increased by forcing fluids. The principle of isotope dilution may be used to increase elimination of radioactive sodium (Na^{24}) and potassium (K^{42}). In some cases the elimination of I^{131} may be increased by the oral administration of inactive iodine. (H.H.D.)

1184 ACTION OF X RAYS ON BILIRUBIN. G. Barac, Marie-Louise Beaumariage, Claudine Cuvelier, and W. Notay (Université, Liege). Arch. Intern. Physiol. Biochim., 69: 95-6(Feb. 1961). (In French)

A study was made of whether bilirubin is oxidized by the free radicals forming during the radiolysis of water containing this pigment, and, if so, whether this can be prevented by radioprotective substances. Bilirubin solutions of various concentrations of pH 5.8, 7.35, or 13.3 were irradiated at a rate of 236 r/sec. In solutions containing 10 mg/l the pigment was destroyed at doses above 5000 r and this was 98% complete at 100,000 r. Similar results were obtained at all 3 pH values. The following substances protected bilirubin, some of them at concentrations as low as 0.001M: ascorbic acid, cysteine, cystine, ergothionine, 5-hydroxytryptamine, propylthiouracil, methylthiouracil, thiouracil, tryptamine, cysteamine, cystamine, 5-hydroxyindoleacetic acid, thiosalicylic acid, and thioacetamide. Thiourea, urea, and glucose were ineffective at 1000-fold higher concentrations. Most of the compounds affording radioprotection to bilirubin contain labile H atoms. Radio-oxidation of bilirubin does not give rise to biliverdin, but probably to a product similar to that formed by direct oxygenation. (H.H.D.)

1185 MEASUREMENT OF RADIOISOTOPES WITH THE AID OF A SCINTILLATION SOLUTION. W. G. Verly (Université, Liege). Arch. Intern. Physiol. Biochim., 69: 389(May 1961). (In French)

In this method the radioisotope-labeled compound is dissolved in a scintillating solution which is read by a photomultiplier. This method is particularly useful for emitters of soft beta radiation, especially H^3. The scintillating medium must be in true solution to obviate any correction for self absorption. A counting efficiency of 25% for H^3 and 60% for C^{14} of S^{35} can be attained, but this efficiency varies with the chemical composition of the scintillating solution, which makes calibration essential. The most useful solvents are xylene, toluene, and dioxane, to which various other solvents or solubilizing substances can be added. Stabilized suspensions or emulsions of scintillation media in the form of gels can be used, but these heterogeneous systems introduce the problem of correction for autoabsorption and calibration is sometimes impossible. (H.H.D.)

1186 NEW RESULTS ON THE IRRADIATION OF BILIRUBIN BY MEANS OF X RAYS. Marie-Louise Beaumariage and G. Barac (Université, Liege). Arch. Intern. Physiol. Biochim., 69: 587-9(Sept. 1961). (In French)

Various radioprotective agents were tested in irradiated aqueous solutions of bilirubin and its glucuronide derivatives. Hydroxyindoleacetic acid protects the pigment from oxidation but indoleacetic acid does not, showing the importance of the hydroxyl group, which may provide labile H. Dehydroascorbic acid is as protective as cystine and cystamine; these 3 compounds lack labile H atoms and their mode of action is not readily explainable. Ovalbumin, which does not bind bilirubin or its glucuronides, is not radioprotective at a concentration of 50 g/l. Peroxidase and catalase are inactive, which suggests that the radiation-generated oxidizing agent is not oxygen. Bilirubin in acetone or chloroform solution is strongly oxidized by irradiation and to a much less extent in ethanol solution. Irradiation of chloroform alone causes the formation of peroxides which can oxidize bilirubin, and the presence of α-tocopherol inhibits the oxidation of bilirubin in organic solvents. Irradiation of the dry pigment does not affect it. (H.H.D.)

1187 PHOTOREDUCTION AT λ 705 mμ IN ADAPTED ALGAE. Norman I. Bishop and Hans Gaffron (Florida State Univ., Tallahassee). Biochem. Biophys. Research Communs., 8: 471-6(Aug. 31, 1962).

Results are reported from studies on the mechanism of oxygen evolution from water in the light in green algae. Relative rates of photosynthesis and photoreduction at various light intensities were measured in the same cell in Ankistrodesmus and in a mutant of Scenedesmus that is incapable of evolving oxygen but retains all other properties necessary to achieve CO_2 reduction. Results indicate that the long wave length region is responsible for the production of a strong reductant and that the short wave length region is responsible for the production of a strong oxidant that eventually will yield oxygen. A combination of the two primary systems is necessary for the photolysis of water. It is suggested that in complete photosynthesis the production of a strong reductant and a weak oxidant with one quantum would be coupled by the quinone system to the mechanism that produces a weak reductant and a strong oxidant. Examples of this scheme are outlined. (C.H.)

1188 SUBSTRATE INTERCHANGES AND OXYGEN TRANSFERS CATALYZED BY GLUTAMINE SYNTHETASE AT EQUILIBRIUM. D. J. Graves and P. D. Boyer (Univ. of Minnesota, Minneapolis). Biochemistry, 1: 739-47(Sept. 1962).

Experiments with isotopes are reported on the rates of various interchanges at equilibrium as catalyzed by glutamine synthetase from peas. A continued increase in the rate of the $P_i \rightleftharpoons$ ATP interchange with increase in the glutamate and glutamine concentrations, and an increase in the rate of the $P_i \rightleftharpoons$ ATP and glutamate $\rightleftharpoons$ glutamine interchanges with increases in the concentrations of P_i and ATP was observed. Such results eliminate the possibility of compulsory binding sequences with glutamate, glutamine, P_i, or ATP as the last reactant to bind. Effects of increase in NH_4^+ plus glutamine or of ADP plus ATP are consistent with partially compulsory pathways of substrate binding. The interchange of O^{18} between the γ-carboxyl group of glutamate and both the P_i and the terminal phosphoryl group of ATP was found to be considerably more rapid than was estimated from the extent of the $P_i \rightleftharpoons$ ATP interchange. This demonstrates lack of spatial selectivity by the enzyme between at least two oxygens of bound P_i and adds further evidence to the previous conclusion that interconversion of bound substrates is a rapid step in the catalysis. Loss of O^{18} from glutamate as calculated for the extent of the glutamate $\rightleftharpoons$ glutamine interchange gives evidence for a spatial selectivity by the enzyme between two oxygens of the bound glutamate. (auth)

1189 A TECHNIQUE FOR NEUTRON ACTIVATION OF PHOSPHORUS COMPOUNDS ON PAPER CHROMATOGRAMS. J. R. Robinson (Canada Dept. of Agriculture,

London, Ont.). Can. J. Biochem. and Physiol., 40: 1460-3 (Oct. 1962).

A technique is described for the neutron activation of metabolites containing P on paper chromatograms. The $P^{31}(n,\gamma)$ process occurs during exposure in a reactor. Each strip was given a light plastic coating to minimize disintegration of the paper during handling. End-window Geiger tube scanning coupled to a rate meter and recorder was used in making preliminary and quantitative comparison of the spots containing 0.1 μg or more of P and radioautograms of the strips were made when the background had decayed to a normal value. (C.H.)

1190 THE EFFECT OF X-RADIATION ON NUCLEAR NUCLEOTIDE CONTENT AS STUDIED BY ULTRAVIOLET-MICROSPECTROPHOTOMETRY ON TUMOUR CELLS. D. Killander, B. M. Richards, and N. R. Ringertz (Karolinska Institutet, Stockholm and King's Coll., London). Exptl. Cell Research, 27: 321-5(Aug. 1962).

Preliminary results are reported for studies on the chemical changes occurring in the nucleus of tetraploid Ehrlich ascites tumor after x-irradiation of individual cells. Measurements were made of the dry weight, ultraviolet light absorption at 2650 A, and DNA content of randomly selected cells. Measurements were also made of the nuclear content of RNA after DNA synthesis stopped at the premitotic level. Changes in ultraviolet light absorption were compared with changes in dry weight and DNA content in the same nuclei. Data are presented graphically. The total nuclear absorption at 265 mμ was shown to increase after x irradiation of individual cells with 1100 r in vivo, and part of this increase was shown to be due to an increase in the DNA content of the nuclei. Other ultraviolet-absorbing compounds also accumulated as a result of irradiation. It was concluded that an increase in the nuclear content of RNA and low-molecular nucleotide material takes place after irradiation. (C.H.)

1191 GENETIC INFLUENCE ON THE BACK-MUTATION RATE IN BIOCHEMICAL MUTANT STRAINS OF OPHIOSTOMA. G. Zetterberg (Univ. of Uppsala). Exptl. Cell Res., 27: 560-9(Sept. 1962).

After a certain dose of ultraviolet light, the reversion rate of the uracil-less character was significantly lower in four methionine-uracil-less double-mutants than in two uracil-less single-mutants. No corresponding differences in the killing effect were obtained. After treatments with nitrogen mustard, dimethylsulfate, N-nitroso-N-methylurethan, and x-rays, the reversion rate in question was always lower in the double-mutant than in the single-mutant studied. In the UV-experiments, the effect could not be explained by differences in post-irradiation conditions. There was no evidence for suppressor dependent back-mutations of the uracil-less character. The nature of the antimutator factor and its mode of action are discussed. (auth)

1192 ALVEOLAR CLEARANCE IN DOGS AFTER INHALATION OF AN IRON-59 OXIDE AEROSOL. F. R. Gibb and P. E. Morrow (Univ. of Rochester, N. Y.). J. Appl. Physiol., 17: 429-32(May 1962).

Studies were made of the clearance of an inhaled, insoluble, radioactive dust from the lungs of dogs by the use of an external crystal detector. The dogs received two 60-min exposures, 6 months apart, to an aerosol of $Fe_2^{59}O_3$, having an average count median diameter of 0.09μ and a geometric standard deviation of 1.8. The concentration of Fe^{59} in the inspired air ranged between 0.004-0.017 μc/l. Lung measurements were made immediately after each exposure and up to 30 days postexposure. This procedure was followed in both initial and repeat exposures of each dog. A probe-type scintillation detector fitted with a focusing collimator was used to limit the measurements to specific respiratory tract positions on each dog. The biological half-time for alveolar clearance in the 12 studies ranged from 44 to 82 days with an average value of 62 days. This consistency suggests the probability of a normal clearance rate and the possibility of its use as a functional test. There was no discernible effect of the Fe^{59} radioactivity on the clearance process. Using 88 g for the average lung weight and an effective lung radius of 4.45 cm, the net effective beta and gamma energies were calculated to be 0.12 and 0.14 Mev, respectively. On the basis of a 26-day effective half-life, the total beta-gamma dose to the lung was estimated to be ~5 rads/μc, indicating a range of from 2 to 22 rads in the experimental subjects. (H.H.D.)

1193 EPISOMIC ELEMENT IN A STRAIN OF SALMONELLA TYPHOSA. Stanley Falkow and L. S. Baron Walter Reed Army Inst. of Research, Washington, D. C.). J. Bacteriol., 84: 581-9(Sept. 1962).

An episomic element, F_0-lac$^+$, has been identified in a strain of Salmonella typhosa isolated from a natural habitat. The F_0-lac$^+$ element is transferred at high frequency as a single unit of transmission and replication without linkage to any other genetic character. Cells receiving F_0-lac$^+$ are heterogenotes as if F_0-lac$^+$ is not integrated as part of the linear structure of the chromosome, but rather replicates autonomously or in some other association with the genome. Evidence from complementation tests and transduction experiments is presented that the lac genes carried by F_0 are identical or at least markedly similar to the lac genes of Escherichia coli K-12. The F_0 transmission factor cannot be precisely identified but it does not appear to be phage or colicin. F_0 does exhibit mutual repression with the sex factor, F, of E. coli, and immunological experiments indicate some relationship between F and F_0. (auth)

1194 USE OF P^{32} AS AN AID IN BIOLOGICAL STUDIES OF THE LEAFHOPPER SCAPHOIDEUS LUTEOLUS. C. John Hay and Willard C. Myser (Forest Insect Research Lab., Delaware, Ohio). J. Econ. Entomol., 54: 1260-1(Dec. 1961).

P^{32} was used to tag the insect vector of elm phloem necrosis and to trace this leafhopper's oviposition habits through activated eggs. Elm plants that were treated with 2 mc P^{32} absorbed the solution in 2 to 3 hr. Leafhoppers feeding on these plants reached a radioactive level of more than 30,000 cpm per individual in a few days and reached the maximum found (80,000 cpm) in about 8 days. No ill effects to the activated leafhoppers could be detected. Mortality was comparable to that of the controls. Death resulted naturally or because of injury during handling. Females attained an activity twice that of the males, probably because of their larger size. The average activity per egg was $\frac{1}{36}$ that of the female body and ranged from $\frac{1}{24}$ to $\frac{1}{50}$. Few of the eggs studied exceeded 100 cpm; most were around 50 cpm. Eggs were laid 8 to 30 days after mating and could be traced with the probe of the survey meter to within one-half inch of their exact location. The eggs were laid singly in the corky layer of the bark with 1 or more eggs per spot. Failure to detect eggs after 30 days is attributable to the short half life of the isotope (14.7 days). (H.H.D.)

1195 SEMIQUANTITATIVE AUTORADIOGRAPHY BY THE AID OF THE RING OVEN TECHNIQUE. II. ACCURACY AND SENSITIVITY. Lambert J. Ottendorfer and Herbert Weisz (Technische Hochschule, Vienna). Mikrochim. Acta, 725-34(Mar. 28, 1962). (In German)

A described method of chronoautoradiography for estima-

tion of small amounts of radioisotopes was evaluated. Accuracy, sensitivity, and application of the method for the determination of Co^{60}, Cs^{137}, Zr^{95}, Sr^{90}, Ce^{144}, and Ru^{106} are described. Conversion factors for the other isotopes, when the technique is standardized and calibrated with Co^{60}, are provided. (H.H.D.)

1196 "SELFERS" — ATTRIBUTED TO UNEQUAL CROSSOVER IN SALMONELLA. M. Demerec (Brookhaven National Lab., Upton, N. Y.). Proc. Natl. Acad. Sci. U. S., 48: 1696-1704(Oct. 1962).

A selfer is a mutant that gives rise to wild-type recombinants in matings with itself. Evidence is presented that such mutants are found among auxotrophs of Salmonella typhimurium. It is proposed that unequal crossing-over, involving adjacent bases of the DNA of a gene, is responsible for this phenomenon. (auth)

1197 RADIOLOGIC UNITS AND SYMBOLS FOR RADIOMETRIC AND DOSIMETRIC MEASUREMENTS OF IONIZING RADIATION. H. R. Schinz and R. Wideroee. Schweiz. Med. Wochschr., 92: 931-2(July 28, 1962). (In German)

The units and dosimetry standards proposed by the International Commission on Radiological Units are defined and described. (H.H.D.)

1198 USE OF IODINE-131 TO MEASURE MOVEMENTS OF SMALL ANIMALS. Arthur G. Johanningsmeier and Clarence J. Goodnight (Purdue Univ., Lafayette, Ind.). Science, 138: 147-8(Oct. 12, 1962).

A technique utilizing iodine-131 was developed to study the movements of Microtus pennsylvanicus in the field. I^{131} (0.5 mc) was placed in a polyethylene capsule and inserted beneath the animal's skin. Movements of the animal were then followed for periods of up to 2 weeks by means of a Geiger-Mueller counter attached to an aluminum pole. (auth)

1199 DRY, HIGH RESOLUTION AUTORADIOGRAPHY. Daniel Branton and Louis Jacobson (Univ. of California, Berkeley). Stain Technol., 37: 239-42(July 1962).

Sections of freeze-dried, paraffin-embedded tissues are placed on pieces of thin sheet Teflon backed by a felt pad. The sections are then pressure-mounted on dry photographic emulsion. After suitable exposure, the sections are firmly cemented to the emulsion with 0.45% cellulose acetate in a 10:1 mixture of 2-butanone and acetone. This prevents the specimens from falling off or moving during photographic processing, though the tissue can be stained through the cellulose acetate binder. The method was tested with tissues containing H^3-labeled DNA, and it produced resolution comparable to that obtained with standard liquid emulsion or stripping film techniques. The technique was also successfully used to study the localization of Fe^{59}, C^{14}, Na^{22}, Rb^{86}, P^{32}, and Ca^{45} in plant cells. The results indicated substantial reduction of the redistribution and leaching of soluble substances noted with the standard wet autoradiographic techniques. (H.H.D.)

Biochemistry, Nutrition, and Toxicology

1200 (CEA-tr-R-1611) PROBLEMES ACTUELS DE LA TOXICOLOGIE DES SUBSTANCES RADIOACTIVES. (Actual Problems of Toxicology of Radioactive Substances). E. N. Kurlyandskaya (Kurliandskaia). Translated into French from Vestnik Akad. Med. Nauk S.S.S.R., No. 3, 49-55(1957). 19p.

A bibliographic review is given of Russian studies on the principal problems of the toxicology of radioactive substances. The chemical behavior of radioactive substances introduced into an animal body is first studied. It was shown that the chemical properties, location, and metabolism of the radioisotopes introduced affect the clinical pattern of radiation sickness. The phases in the development of radiation sickness are tabulated and discussed. The problem of the determination of the maximum permissible concentration of radioactive materials is reviewed in some detail with a critique of the studies and conclusions made by Morgan. Delayed reactions and their importance in the formation of tumors are discussed in conclusion. (J.S.R.)

1201 STUDIES ON THE COAGULATION OF CHICKEN BLOOD. VII. USE OF NICKEL OXALATE, BISMUTH OXALATE, CADMIUM PHOSPHATE AND BISMUTH PHOSPHATE FOR DIFFERENTIATION AND ASSAY OF STRONTIUM CARBONATE NON-ADSORBABLE LABILE FACTORS. Oeyvind Soerbye and Inger Kruse (Polytechnic Inst., Copenhagen). Acta Chem. Scand., 16: 1662-74(1962). (In English)

Twenty-five crystalline adsorbents were tested for adsorption of labile factor activity from strontium carbonate preadsorbed oxalated chicken plasma and shown to adsorb only a part of the total activity. The adsorbents belong to four different groups, represented by the title compounds, adsorbing four different labile factors for which provisional names are suggested: ϵ(epsilon)-factor was selectively adsorbed by nickel oxalate, μ(mu)-factor by bismuth oxalate, ν(nu)-factor by cadmium phosphate, and ρ(rho)-factor by bismuth phosphate. The factors were different from the λ-, π-, γ-, and β-factors selectively adsorbed by adsorbents tested previously. The activity of each of the eight factors depended on the concentration of only one or two of the other seven. None of the factors appeared to be functionally identical. The ϵ-, μ-, ν-, and ρ-factors did not contribute to the labile factor activity measured when thromboplastin was replaced by Russell's viper venom, with or without added cephalin. They are regarded as thromboplastin specific labile coagulation factors. (auth)

1202 SEXUAL DIFFERENCE IN THE I^{131} UPTAKE BY THE SUBMAXILLARY GLANDS IN A2G MICE. A. B. Houssay, Francisca R. Alberti, M. Slatopolsky Cantis, E. Thierer, and J. M. Rosner (Centro de Endocrinología Ministerio de Asistencia Social y Salud Pública, Buenos Aires). Acta Physiol. Latinoam., 11: 190-200(1961). (In English)

In constrast to previous negative results in rats, the submaxillary and sublingual glands (but not the parotids) of A2G mice have the property of concentrating I^{131}. There is a marked sexual difference in the concentration of I^{131} by submaxillary glands, this ability being greater in males than in females; this coincides with the greater height of the male alveolar ducts. In male animals, castration decreased the concentration of I^{131} when sufficient time was allowed to elapse after operation for atrophy of the submaxillary glands to attain 20%. Castration does not reduce the concentration of I^{131} by submaxillary glands in females. Injection of testosterone propionate greatly increased the concentration of I^{131} by submaxillary glands in castrated mice. However, the estradiol benzoate and dipropionate did not alter this concentration. There is an evident parallelism between the height of the epithelium of the alveolar ducts and the concentration of I^{131} by the submaxillary glands, which suggests the role of this epithelium in the concentration of I^{131}. It is apparently selectively taken up from plasma by epithelial cells by active transport. (H.H.D.)

1203 ENDOCRINE GLANDS AND SECRETION OF I^{131} BY THE SUBMAXILLARY GLAND OF C3H MICE. J. L. Llach (Inst. of Experimental Biology and Medicine, Buenos Aires). Acta Physiol. Latinoam., 11: 252(1961). (In English)

Effects of castration, adrenalectomy, and administration of testosterone, estradiol, corticosterone, and aldosterone on the concentration of I^{131} by the submaxillary gland of male and female C3H mice were studied. The ratio between I^{131} per mg of submaxillary gland and I^{131} per mg of blood (SM/B ratio) was taken as an index of the submaxillary gland's ability to concentrate I. Castration increased the SM/B ratio in males but did not modify it in females, so that in castrated animals the sexual difference in the ratio became more evident. Administration of testosterone to castrated males restored the changes induced by castration. Estradiol in castrated females diminished the SM/B ratio in proportion to the dose. Adrenalectomy in both sexes increased the SM/B ratio. In adrenalectomized animals, corticosterone diminished the ratio to the normal value and aldosterone had no action. Corticosterone in normal mice diminished the uptake by the submaxillary gland in males and increased it in females. Aldosterone raised the SM/B ratio in both sexes. These changes may occur through 2 mechanisms: (1) structural modification of the submaxillary gland, and (2) functional alteration, mainly in salivary secretion. (H.H.D.)

1204 INCORPORATION OF I^{131} BY THE HUMAN THYROID: AUTORADIOGRAPHIC STUDY. A. J. Andrada, R. Dendukes, F. Mueller, and E. I. Hernández (Hospital Tornú, Buenos Aires). Acta Physiol. Latinoam., 11: 279-80(1961). (In English)

Localization of I^{131} within histologic structures of the thyroid gland was studied by stripping-film autoradiography in biopsied specimens 24 hr after injection of 2 mc I^{131}. The distribution pattern could be correlated with the state of follicle cells and colloid deposits. Uptake was not uniform but depended on the height of these cells, the higher the cells the lower the uptake. Exceptions to this rule, i.e., variations in uptake by epithelium of the same height, support the concept that intrafollicular changes in I^{131} metabolism reflect phases of follicular function. In various thyroid disorders the I^{131} uptake could generally be correlated with follicular function. (H.H.D.)

1205 EFFECT OF STRONTIUM ON CARDIAC CONTRACTILITY AND MEMBRANE RESTING POTENTIALS. W. G. Nayler and P. F. Emery (Baker Medical Research Inst., Melbourne). Am. J. Physiol., 203: 844-8(Nov. 1962).

Isotonic contractions and transmembrane resting potentials were recorded both before and after the addition of ethylenediaminetetraacetic acid (EDTA) to toad hearts perfused with Ringer's solution containing either Ca^{2+} or Sr^{2+}. After EDTA perfusion the introduction of Ringer's solution containing Sr^{2+} resulted in contracture and a low resting potential and the introduction of Ringer's which contained Ca^{2+} resulted in restoration of normal contractility and transmembrane potentials. These results are discussed according to the hypothesis that Sr^{2+}, unlike Ca^{2+}, does not maintain the resting membrane potential. (auth)

1206 Ca^{45} AND Sr^{89} MOVEMENTS WITH CONTRACTION OF DEPOLARIZED SMOOTH MUSCLE. Nick Sperelakis (Western Reserve Univ., Cleveland). Am. J. Physiol., 203: 860-6(Nov. 1962).

Previous findings showed that contractions of depolarized muscle bypass excitation-contraction coupling and that Sr replaces Ca in the contractile machinery but not in coupling. Polarized and K-depolarized thin strips of circular layer of cat intestine were subjected to electric fields. Washout curves for Ca^{45} from resting muscles were composed of two exponentials with half-times of 8 min and 60 min. Ca influxes were increased in contracting muscles in both polarized and depolarized conditions. Resting influx was greater in K-Tyrode than in normal Tyrode's solution. With Sr the ratio of influxes of stimulated to resting polarized muscles was not significantly different from 1.0; contractions of polarized muscles were weak due to uncoupling. Uncoupling produced by 20 mM/liter Mg resulted in a ratio of Ca influxes of stimulated to resting polarized muscles not significantly different from 1.0. It is suggested that Ca entrance is not the sole coupling event and that increased Ca or Sr influx is more closely related to contraction than to changes in membrane potential. (auth)

1207 STOP-FLOW STUDIES ON RENAL HANDLING OF LITHIUM IONS IN THE DOG. Louis D. Homer and Sidney Solomon (Medical Coll. of Virginia, Richmond). Am. J. Physiol., 203: 897-900(Nov. 1962).

Stop-flow experiments were performed on dogs after serum Li concentrations had been raised to 10 to 21 mEq/liter with intravenous infusions of Li salts. Li is actively reabsorbed at a distal portion of the nephron close to the site of sodium and potassium reabsorption. Li may cause alkalinization of the urine by inhibiting H^+ secretion. Stimulation of K secretion by Li could not be demonstrated. Li may reduce K reabsorption. (auth)

1208 COURSE OF DEUTERIATION AND SOME PHYSIOLOGICAL EFFECTS OF DEUTERIUM IN MICE. Joseph J. Katz, Henry L. Crespi, Dorice M. Czajka, and Asher J. Finkel (Argonne National Lab., Ill.). Am. J. Physiol., 203: 907-13(Nov. 1962). (TID-16201)

The course of deuteriation was followed in mice given various concentrations of D_2O in the drinking water. Equilibrium deuteriation in the body fluids is 95% attained by the 10th day, and from these values the experimental conditions leading to desired levels of deuteriation in mice are readily specified. The incorporation of deuterium into liver, kidney, and spleen reaches equilibrium by the 3rd week. Incorporation of deuterium into brain is much slower but eventually reaches approximately the same value. Median survival times for mice deuteriated at various D_2O levels in the drinking water range from 60 days, for mice drinking 40% D_2O, to 12 days for mice drinking 75% D_2O. (auth)

1209 THE LEVEL OF STRONTIUM-90 IN HUMAN AND ANIMAL BONE. Jean Goffart (Université, Liege). Arch. Intern. Physiol. Biochim., 69: 505-8(Sept. 1961). (In French)

In calf bones assayed from May 1959 to March 1960 the Sr^{90} content varied from 9.2 to 13.7 $\mu\mu$/g Ca. The level showed no significant monthly variation during this period. The forage consumed by these animals and the location from where they were obtained were uniform which may account for the low variation in values. The variation was considerably higher in human bone (femur) samples, which may be attributed to the large individual differences in human diets. The human bone Sr^{90} content varied from 0.0 to 0.194 (as $\mu\mu$c/g Ca) for persons aged 27-86 yr, with a mean of 0.074. This is very close to a previously reported value in adult Europeans in 1955 of 0.071 $\mu\mu$c/g Ca. Thus, contamination of human bones with Sr^{90} has increased only slightly from 1955 to the present time (May 1959 to Dec. 1960). (H.H.D.)

1210 γ-ACTIVITY MONITORING DURING THE INHALATION OF RADON. L. S. Ruzer. At. Energ. (USSR), 13: 384-5(Oct. 1962). (In Russian)

In the case of the deposition of α- and β-active aerosols in the respiratory system, the activity of the live subject usually cannot be directly determined and only the concentration of the aerosol in the air is measured. Calculation of the average holdup time in the system from such data often leads to erroneous values. It was previously reported that from the α-, β-, and γ-active daughters of Rn the absorbed dose may be estimated (Atomnaya Energiya, 4: 144 (1958) No. 2 and 8: 542 (1960) No. 6), without requiring a determination of Po^{218}, Pb^{214}, and Bi^{214} in the air. Tabulations were prepared of the various parameters for inhalation periods of three and six hours. For periods of t > three hours, the total absorbed dose may be calculated from the expression: $D^{\alpha} \approx 2.1 \times 10^{3} A_{\gamma} \times t$ (in ergs) where A_{γ} indicates the activity of the γ-emitting daughters in the respiratory system. The method derived makes it possible to monitor and to control the activity distribution and thus the absorbed dose in the respiratory system. (TTT)

1211 STUDIES ON BACTERIAL PHOTOPHOSPHORYLATION. V. STOICHIOMETRY AND KINETICS OF PHOTOPHOSPHORYLATION AND ADENOSINE 5'-TRIPHOSPHATASE AND EFFECTS OF DIVALENT METAL IONS. Mitsuo Nishimura (Univ. of Pennsylvania, Philadelphia). Biochim. Biophys. Acta, 64: 345-52(Oct. 22, 1962).

The stoichiometry and kinetics of photophosphorylation and dark ATPase in Rhodospirillum rubrum chromatophores were studied by the methods of pH-change recording, phosphate analysis, and chromatography. A stoichiometric ratio of $\Delta ATP/-\Delta H^{+}$/added ADP = 1.0/0.9/1.0 was observed in photophosphorylation. The presence of Mg^{2+}, ADP and phosphate is necessary for the maximal phosphorylative activity. The rate of photophosphorylation increased remarkably with higher concentrations of these components. The apparent Michaelis constant for ADP was calculated to be $1.5 \cdot 10^{-5}$ M, that for phosphate was $1.1 \cdot 10^{-4}$ M. The effects of seven species of divalent metal ions on photophosphorylation were compared. Mg^{2+} had the greatest effect on the activity. Mn^{2+}, Sr^{2+} and Ca^{2+} were effective to a lesser extent in certain concentration ranges. Zn^{2+} was slightly inhibitory and Be^{2+} and Cd^{2+} were strong inhibitors. ATPase reaction of chromatophores in the dark was observed. No adenylate kinase activity was detected. Mg^{2+} was stimulatory for this ATPase reaction. The apparent Michaelis constant for ATP was $1.5 \cdot 10^{-4}$ M. (auth)

1212 STUDIES OF STRONTIFICATION IN VITRO. Albert E. Sobel and Sidney Nobel (Jewish Hospital, Brooklyn). Clin. Chem., 8: 436-7(Aug. 1962).

Using rachitic epiphyseal cartilage from rats, a study was made of strontification and calcification in vitro. The formation of a crystal from a solution takes place in 3 stages: (1) the formation of nuclei of crystallization (nucleation); (2) growth of crystals upon these nuclei; and (3) the cessation of crystal growth. These studies with rachitic rat cartilage indicate that in solutions of Ca and phosphate, nucleation takes place with relative ease. Nucleation takes place with Sr and phosphate, but is more difficult to achieve. Small amounts of Ca inhibit nucleation with Sr but once Sr phosphate nuclei have been produced, Ca ion does not inhibit the crystal growth of Ca phosphate. X-ray diffraction studies indicate that the crystals are Sr hydroxyapatite and Ca hydroxyapatite. (H.H.D.)

1213 REMOVAL OF RADIOSTRONTIUM IN MAN BY ORALLY ADMINISTERED AMMONIUM CHLORIDE TWO WEEKS AFTER EXPOSURE: THE EFFECT OF LOW AND HIGH CALCIUM INTAKE. Herta Spencer and Joseph Samachson (Montefiore Hospital, New York). Clin. Sci., 20: 333-43(June 1961). (TID-6738)

The removal of radiostrontium was studied in man by means of orally administered ammonium chloride during low and high calcium intake both at the time of the injection of the Sr^{85} tracer and two weeks thereafter. During low calcium intake, orally administered ammonium chloride was as effective in removing radiostrontium two weeks after administration of the tracer as at the time of the injection of the tracer. Ammonium chloride given in the late phase during high calcium intake was less effective than in the same phase during low calcium intake, due to the higher urinary excretion of calcium and of radiostrontium prior to the administration of ammonium chloride during high calcium intake. Two weeks after exposure, the Sr^{85} body burden was approximately twice as high in patients maintained on low calcium intake as in those receiving calcium supplements. The excess radiostrontium excretion induced by ammonium chloride was approximately twice as high in terms of the retained dose in the former as in the latter group. (auth)

1214 THE MUTAGENIC EFFECT OF VANILLIN AND OF SOME OF ITS DERIVATIVES. G. I. Efremova (Inst. of Chemical Physics, Academy of Sciences, USSR). Doklady Akad. Nauk SSSR, 146: 456-9(Sept. 11, 1962). (In Russian)

A dose of 3 to 60 mgs of crystalline vanillin was added to nutrient broth for Drosophila melanogaster in the early larval stage (48 hours old) or as grown males. The progeny of the flies was analyzed for the number of lethal mutations associated with sex. An increase in mutagenesis by a factor of four was observed. The 5-iodovanillin and 5-bromovanillin derivates had an even higher mutagenic effect than vanillin, particularly on the full-grown sex cells (spermatogonia). The mutagenic effect of vanillin was increased by dissolving it in a 2M solution of triacetin $(CH_3COO)_3C_3H_5$, in which the vanillin is readily soluble. The incidence of melanitic cancer was increased significantly by adding vanillin to the diet of an insect. The results are of significance because of the widespread use of vanillin in the food industry. Vanillin acts as an antioxidant, and interacts with various oxidases. (TTT)

1215 THE USE OF ORGAN CULTURE TO STUDY ^{131}I UPTAKE AND METABOLISM OF THYROID TISSUE. K. Hagmueller and I. Leslie (Queen's Univ., Belfast). Exptl. Cell Res., 27: 396-400(Sept. 1962).

Observations on cells in tissue culture confirmed that isolated thyroid cells are unable to concentrate I^{131} or to form thyroid hormones when the cells are proliferating rapidly. This loss of specialization may possibly be linked to the rapid decline in the activity of two respiratory enzymes in roller cultures of freshly explanted cells. Alternatively, the ability of thyroid tissue to complete the process of iodination and produce active hormone may depend upon the presence of intact follicles containing colloid. The protein binding of I^{131} established with organ cultures of thyroid, and the experiments of Wollman and Wodinsky and Nadler on whole thyroid gland, support this assumption. In assessing the response of normal or pathological tissue to hormones it is clearly important to employ an organ culture technique in which the integrity of the tissue and cells can be maintained over a period of days. (auth)

1216 EVALUATION OF THE SODIUM TURNOVER WITH THE USE OF Na^{22} IN SOME ENDOCRINE DISORDERS. S. Lamperi and F. di Pietrantonj. Folia Endocrinol. (Pisa), 14: 812-25(Dec. 1961). (In Italian)

Sodium turnover was investigated in patients with endocrine disorders using Na^{22}. The results obtained permit the following conclusions: Na^{22} is very reliable for the evaluation of organic sodium turnover. Although a good correlation exists between isotopic and chemical methods of investigation, the former permits a quicker and more precise evaluation. The variations observed in the sodium turnover can be related either to endocrine disorders or to an abnormal reactivity of tissues to hormones. (auth)

1217 URINARY EXCRETION OF CALCIUM AND STRONTIUM-85 IN MAN. Joseph Samachson and Herta Spencer-Laszle (Montefiore Hospital, New York). J. Appl. Physiol., 17: 525-30(May 1962).

The extent to which the urinary excretion and renal clearance of Sr^{85} can be related quantitatively to the excretion and clearance of stable Ca was investigated. Urinary Sr^{85} and Ca excretions were compared in 45 patients after intravenous or oral administration of Sr^{85}. Although correlations were found between Sr^{85} and Ca excretions, there was a wide range of Sr^{85} excretions at a given Ca excretion. In general, patients with a urinary Ca of 300 mg/day excreted from 50 to 60% of an intravenous Sr^{85} dose in 12 days, as contrasted with an Sr^{85} excretion of 15-25% in patients excreting 40 mg Ca/day. The best correlation appeared to be between Sr^{85} and Ca clearances. Empirical equations and curves are given to permit an estimate of urinary Sr^{85} excretion from Ca excretion. The renal tubular reabsorption of Ca was greater than that of Sr^{85} in all patients, whether Ca excretion was low or high. As tubular reabsorption becomes less efficient, the Sr^{85} clearance and Ca clearance increase together, but not in the same proportion, the ratio of Sr^{85}/Ca clearance decreasing. As the clearances represent that portion of Sr^{85} and of Ca in the glomerular filtrate which escapes reabsorption, it would appear that, with decrease in the efficiency of tubular reabsorption, discrimination between 2 ions becomes less. However, the ratio of the calculated reabsorption of Ca/Sr^{85} increased from 1.008 to 1.04. It is uncertain whether the ratio of Sr^{85}/Ca clearance or the relative reabsorption of Ca/Sr^{85} better expresses the extent of renal discrimination in favor of Ca. (H.H.D.)

1218 THE DISTRIBUTION OF C^{14} IN GLYCOGEN FROM DEUTERATED GLYCEROL-C^{14} AS A MEASURE OF THE EFFECTIVENESS OF TRIOSEPHOSPHATE ISOMERASE IN VIVO. Irwin A. Rose, R. Kellermeyer, Rune Stjernholm, and Harland G. Wood (Yale Univ., New Haven, Conn. and Western Reserve Univ., Cleveland). J. Biol. Chem., 237: 3325-31(Nov. 1962).

Glycerol-1-C^{14} and glycerol-2-C^{14} were labeled with deuterium in the stereospecific position which is removed by triosephosphate isomerase during conversion of dihydroxyacetone phosphate to glyceraldehyde 3-phosphate. Both deuterated and nondeuterated glycerol-C^{14} were administered orally to rats and the distribution of C^{14} in the hexose units of liver glycogen was investigated. It was established that the presence of deuterium in the glycerol causes an increased asymmetry of the C^{14} in the glucose unit. It is known that purified liver triosephosphate isomerase uses dihydroxyacetone phosphate less rapidly when it is deuterated at the position cleaved than it does the nondeuterated dihydroxyacetone phosphate when the two species are mixed. Theoretical considerations indicate that discrimination against the deuterated species of dihydroxyacetone phosphate would be reflected in the labeling of the glyceraldehyde 3-phosphate and dihydroxyacetone phosphate and that the extent of the difference in labeling is dependent on the rate of the reversible interconversion of glyceraldehyde 3-phosphate and dihydroxyacetone phosphate. It was shown that the labeling of the glucose is consistent with predictions for such discrimination. The results provide strong evidence for the nonequilibration of the triosephosphate pools. It is concluded that failure to achieve isotopic equilibration at the triosephosphate stage is the explanation for the unequal labeling of the glucose units of liver glycogen derived from administered glycerol-C^{14}. The present experimental approach demonstrates the use of deuterium to alter rates of reactions to evaluate the extent of equilibration of metabolic intermediates under normal physiological conditions in vivo. (auth)

1219 DISTRIBUTION AND INCORPORATION OF RADIOACTIVE PHOSPHORUS IN THE DOUGLAS-FIR BEETLE. S. C. Fang (Oregon State Coll., Corvallis) and Don Allen. J. Econ. Entomol., 48: 79-82(Feb. 1955).

The distribution of P^{32} in different parts of the body of Douglas-fir beetle, Dendroctonus pseudotsugae Hopkins, and its incorporation into phosphorylated intermediates was studied. Most phosphate esters which are known to be intermediates of glycolysis were found to be present in the beetle. (auth)

1220 AN INTERPRETATION OF RADIOISOTOPE TURNOVER DATA. J. Anderson, R. W. S. Tomlinson, and S. B. Osborn (King's Coll. Hospital, London). Lancet, 1: 949-50(May 5, 1962).

In recent studies on the distribution of Ca^{47} in human subjects, as was previously found with Ca^{45}, the diffusion of radioisotope into body compartments could be described more simply by a power law than by an exponential function. In an exponential function the specific activity (S) at time t is expressed: $S = S_0e^{-kt}$, where S_0 is the value of S at t = 0, and k is a constant. From this it follows that $dS/dt = -kS$. On the other hand, a power-law function leads to the relation: $S = at^{-k}$, where a is a constant, and hence $dS/dt = -(kS/t)$. The exponential function yields a straight line when plotted on log-linear graph paper, while the power-law function gives a straight line when plotted on log-log paper. Re-examination of previous data obtained with Ra, radiomercury, and Sr^{89} shows that the data fit the power law more satisfactorily than an exponential function. However, other data which appear to involve only diffusion, such as with H_2^3O, show a better fit with exponential functions. It is concluded that in processes involving active cellular transport, as with bone-seeking radioisotopes, exponen ial functions are inadequate to describe the data, and that analysis of the data assuming a power-law function facilitates differentiation between various bone diseases studied with radioisotopes. (H.H.D.)

1221 INTERPRETATION OF RADIOISOTOPE TURNOVER DATA. H. I. Glass, J. MacGregor, and B. E. C. Nordin (Gardiner Inst., Western Infirmary, Glasgow). Lancet, 2: 198-9(July 28, 1962).

Anderson et al. (Lancet, 1: 949(1962)) stress the observation that the fall in plasma specific activity after intravenous administration of a bone-seeking isotope can be represented as a power function for the first 100 hr or so. They suggest that exponential functions are inadequate to describe processes which involve active cellular transport and claim that analysis of the data assuming a power-law function facilitates differentiation between various bone disorders. Disappearance of radiocalcium and radiostrontium from plasma is not a mono-exponential function, at least during the first few weeks after administration of the isotope, and when plasma specific activities are plotted on semi-logarithmic paper the resulting line is not straight. The explanation may be sought in slow exchange processes

between extracellular fluid and bone mineral which produce a net transfer of isotope into bone. It is suggested that after an equilibrium period of about 24 hr the system is essentially a 2 compartment one in which the immediately exchangeable Ca pool represents the 1st compartment and some additional mineral in the bone represents the 2nd compartment. Mathematical analysis of such a model yields a complex exponential function not unlike the observed plasma-specific-activity/time curves in man. It may be misleading to adapt an arbitrary line-fitting procedure, and the postulated power function cannot be taken to imply an active transport mechanism. On the contrary, human experiments indicate that during the first few weeks after administration of a bone-seeking isotope most of the activity which finds its way into the skeleton does so by purely physical processes. (H.H.D.)

1222 RETENTION AND EXCRETION OF CAESIUM-137 BY MAN. Mary P. Taylor (Radiological Protection Service, Sutton, Surrey, Eng.), J. Vennart, and D. M. Taylor. Phys. Med. Biol., 7: 157-65(Oct. 1962).

Measurements of Cs^{137} in the bodies and urine of five males who had accidentally acquired a body burden of this radio-nuclide are described. It was found that the half-period of retention of Cs^{137} in the body varied between 80 and 130 days and that the average daily urinary excretion was 0.6% of the body burden. (auth)

1223 METABOLISM OF THE CHELATING AGENT DIETHYLENETRIAMINE PENTAACETIC ACID (C^{14}DTPA) IN MAN. Estelle Stevens, Betty Rosoff, Murray Weiner, and Herta Spencer (Montefiore Hospital, New York and Veterans Administration Hospital, Hines, Ill.). Proc. Soc. Exptl. Biol. Med., 111: 235-8(Nov. 1962).

Intravenously injected C^{14}DTPA in man is quantitatively excreted in urine in 24 hours. Following oral ingestion of C^{14}DTPA, the major portion of the chelate passes unabsorbed through the intestine. However, the presence of the C^{14} chelate in urine is evidence for absorption of some, although small, amounts of the chelating agents. The metabolism of DTPA was shown to be similar to that of EDTA. (auth)

1224 EFFECT OF DEUTERIUM OXIDE INCORPORATION OF P^{32} INTO RAT LIVER DEOXYRIBONUCLEIC ACID. David A. Bray and John F. Thomson (Argonne National Lab., Ill. and Lawrence Coll., Appleton, Wis.). Proc. Soc. Exptl. Biol. Med., 111: 380-3(Nov. 1962).

Experiments were carried out in an attempt to determine the effects of D_2O administration on incorporation of P^{32} into rat liver DNA. With increasing concentrations of D_2O, there was a progressive decrease in DNA synthesis; in rats in which 30% of the body water was replaced by D_2O the incorporation of P^{32} into DNA was reduced to about one-fifth of normal. (auth)

1225 CALCIUM AND STRONTIUM UPTAKE BY RAT LIVER AND KIDNEY MITOCHONDRIA. Frank R. Mraz (General Electric Co., Richland, Wash.). Proc. Soc. Exptl. Biol. Med., 111: 429-31(Nov. 1962). (HW-SA-2669)

The uptake of Sr^{85} by mitochondria from rat kidney and liver was reduced to a greater degree by added calcium than was the uptake of Ca^{45}. Uptake of Sr^{85} was increased to a greater degree by addition of strontium than was the uptake of Ca^{45}. ATP was required for the uptake of Sr^{85} and Ca^{45} by kidney mitochondria, while cytochrome c was not. Results with liver mitochondria were more variable and the requirement for ATP appeared to be influenced by calcium in the medium. (auth)

1226 GASTROINTESTINAL SITES OF ABSORPTION AND ENDOGENOUS SECRETION OF CALCIUM AND PHOSPHORUS IN DAIRY CALVES. P. T. Chandler and R. G. Cragle (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn. and Univ. of Tennessee, Knoxville). Proc. Soc. Exptl. Biol. Med., 111: 431-4(Nov. 1962).

An indicator method using Ce^{144} to determine calcium and phosphorus absorption and secretion in dairy calves has been described. Definite secretions of phosphorus into the rumen and omasum and absorption of calcium and phosphorus from the abomasum have been demonstrated. The points of calcium absorption are not always associated with phosphorus secretion. Appreciable secretions of calcium and phosphorus in the lower tract are not present or they are balanced by an equal absorption. There was no difference noted with age as to the metabolism of calcium; however, a significant difference was found in phosphorus metabolism with age. (auth)

1227 CARBON DIOXIDE INDUCED ACIDOSIS IN PREGNANT RATS AND CARIES SUSCEPTIBILITY OF THEIR PROGENY. C. T. G. King, Ann Wilk, and F. J. McClure (National Inst. of Dental Research, Bethesda, Md.). Proc. Soc. Exptl. Biol. Med., 111: 486-9(Nov. 1962).

Respiratory acidosis in the rat induced by exposure to 30% carbon dioxide in 70% oxygen previous to the 10th day of gestation significantly increased the severity of dental caries in the offspring subsequently fed a cariogenic skim milk diet. This treatment did not have any significant effect when applied after the 15th day of pregnancy. (auth)

1228 ASSAY OF STRONTIUM-90 IN HUMAN BONE IN THE UNITED KINGDOM. RESULTS FOR 1960, PART II. Medical Research Council Monitoring Report Series No. 3. (Gt. Brit. Medical Research Council, London). Oct. 25, 1961. 9p. 1s. 3d. (HMSO)

Data are tabulated on levels of Sr^{90} in samples of human bone from deaths in the United Kingdom during the second half of 1960. (C.H.)

1229 THE INCORPORATION OF RADIOACTIVE IRON-59 INTO TOBACCO MOSAIC VIRUS AND YEAST NUCLEOPROTEIN. Lawrence Fook Eng. Thesis, Stanford, Calif., Stanford Univ., 1962. 150p.

The significance and origin of the iron associated with tobacco mosaic virus first reported by Loring and Waritz, Science, 125: 646(1957) were further investigated with a radioactive tracer study. It was shown that iron-59 was incorporated in much larger amounts in the isolated virus under conditions of rapid synthesis in newly-infected Turkish tobacco plants than under conditions prevailing in the plants of the same age that had been infected several weeks. Adsorption experiments showed that all the iron associated with the virus could not be attributed to adsorption. The observations that virus prepared in its most native state contained primarily calcium and magnesium and small amounts of other metals such as iron and manganese and that the iron content of the virus could be decreased considerably if potassium phosphate were added to the infected juice before isolation of the virus were confirmed. Extensive treatment of native virus with sodium versene decreased the iron content of the virus to no more than five atoms per molecule (using a MW of 40×10^6) without changing its infectivity. Flame photometric analysis of virus that was treated extensively with versene showed that it was essentially in the sodium form. The incorporation of iron-59 into tobacco mosaic virus lesions of N. glutinosa leaves was studied by radioautography and iron radioactivity comparisons between comparable areas containing and areas free from local lesions. It was found that the areas with lesions contained more radioactivity than areas free from lesions. Nucleic acid was prepared from the radioactive virus by a phenol extraction procedure. It was found that

the majority of the iron associated with the virus was removed with protein in the phenol extract. A heavier sedimenting nucleate fraction was obtained by ultracentrifugation which contained about four times as much radioactivity as the slower sedimenting nucleate fractions. It was concluded that while iron is not essential for maintaining the infectivity of the virus, it may function in the secondary structure of the virus molecule. The iron contents of the yeast ribosomes and ribonucleic acid were determined by a radioactive tracer study. The ribosomes were prepared by a modified procedure of Chao and Schachman, (Arch. Biochem. Biophys., 61: 220(1956)) from yeast cells cultured in synthetic medium containing iron-59. The total iron content of the medium was determined by chemical analysis and its specific radioactivity per unit of total iron established from the radioactivity of a known aliquot. By assuming that the iron found subsequently in the various fractions had the same specific activity as that of the medium, it was possible to estimate total iron content from radioactivity measurements. Relatively constant iron recovery in the ribosome fractions indicated that iron was distributed in fairly constant proportions between the ribosomes and the rest of the cell components. Some physical and chemical properties of the ribosomal particles were determined. Repeated cycles of purification caused a progressive decrease in the ratio of iron to phosphorus. The average ratio of iron to phosphorus was 10.9, 10.3, and 7.2 mg Fe ger g P for two-, three-, and four-cycle ribosomes while one five-cycle sample contained 7.4 and one seven-cycle preparation contained 5.1 mg Fe per g P. Ribosomal nucleic acid was prepared by the detergent and phenol methods under various conditions. As in the case of tobacco mosaic virus treated with phenol, the majority of the iron in the ribosomal particles was removed with the protein in the phenol extract. A possible function of the iron associated with the ribosomes is discussed. (Dissertation Abstr., 23: No. 3, 1962)

Fallout and Ecology

1230 (ORNL-3328) CYCLING OF CESIUM-134 IN WHITE OAK TREES ON SITES OF CONTRASTING SOIL TYPE AND MOISTURE (thesis). J. P. Witherspoon, Jr., S. I. Auerbach, and J. S. Olson (Oak Ridge National Lab., Tenn.). Nov. 6, 1962. Contract W-7405-eng-26. 152p.

The cycle of cesium-134 (2 μc) in white oak trees on four sites differing soil type and moisture was followed. Gains, losses, and transfers were estimated by sampling from inoculated trees, understory, litter, and soil. With rapid translocation into leaves from initial trunk inoculations in the spring, white oak leaves contained 10^5 to 10^6 dpm per g dry weight by early June. This represented a total transfer of about 40% of the original input. From rains, loss from leaves continued throughout the growing season until September, by which time a total loss of 15% of the observed maximum concentration in leaves had occurred. Approximately 70% of this rain-induced loss reached the mineral soil by September, the remainder located in litter and understory vegetation. Radiocesium transferred from trees via annual leaf fall was two times greater than the quantity exported by rain. With subsequent leaching over the winter months, the litter lost about half of its radiocesium to the mineral soil. Soils on wet sites had significantly greater percentages at lower depths down to 12 in. However, 92% of the total soil radiocesium remained in the top 4 in. on year and seven months after tree inoculation. A definite pattern of distribution, presumably related to rain-leaching and stem flow, was found under tagged trees. 80% of the soil radiocesium was confined to the area within crown perimeters, and 19% occurred in a small area around the trunks. Total annual loss of this radioisotope from inoculated trees was estimated at 19%. Results from analysis of four trees harvested at the end of the study indicated that estimates of radiocesium remaining in trees one year and seven months post inoculation were 13.3 ± 3.0% high. Stable cesium determinations for soil horizons and white oak leaves showed that the amounts of Cs^{134} involved in all stages of this experiment were very small compared to natural levels of cesium. (auth)

1231 YOU, YOUR PATIENTS AND RADIOACTIVE FALLOUT. Shield Warren (New England Deaconess Hospital, Boston). New Engl. J. Med., 266: 1123-5(May 31, 1962). (TID-15402)

In the Shattuck Lecture, delivered to physicians, the composition and hazards of fallout are discussed, and various other sources of radiation in the environment are described. It is concluded that the possible danger from fallout from all nuclear weapons tests to date is less than that encountered from natural sources of radiation by a person moving from Boston to Denver. Recent evidence indicates that the incidence of leukemia, which in some cases may have resulted from radiation exposure, has been declining since 1955, after showing an increased rate between 1937 and 1950. It is suggested that, although radiation exposure from diagnostic x-ray procedures may not constitute an undue hazard, irradiation of the human fetus in utero should be avoided. (H.H.D.)

1232 PENETRATION OF FALLOUT FISSION PRODUCTS INTO AN INDIANA SOIL. David Telfair and John Luetzelschwab (Earlham Coll., Richmond, Ind.). Science, 138: 829-30(Nov. 16, 1962).

Although most of the radioactive fallout reaching the earth stays in the leaf layer and the top inch of soil, some is carried further into the soil and can be detected to a depth of several inches. This report describes a gamma-ray spectrometric study of fallout activity as a function of depth of soil. Total gamma activity deposited from recent tests was found to be over 1.5 curies per square mile at a site in eastern Indiana during July, 1962. (auth)

1233 INFLUENCE OF STABLE Cs AND K ON THE REACTIONS OF Cs137 AND K42 IN SOILS AND CLAY MINERALS. H. Nishita, P. Taylor, G. V. Alexander, and K. H. Larson (Univ. of California, Los Angeles). Soil Sci., 94: 187-97(Sept. 1962). (UCLA-496)

Experiments were conducted to study the influence of stable Cs and K on the reactions of tracer quantities of Cs^{137} and K^{42} in soils and clay minerals, using an equilibrium batch method. Tracer quantities of both Cs^{137} and K^{42} were strongly sorbed in soils and clay minerals. Cesium was more strongly sorbed than K. Since the initial trace quantities of carrier-free Cs^{137} were very strongly sorbed, the sequence of the addition of the tracer radioisotope in relation to the addition of stable Cs and K determined the level at which equilibrium was attained. The absolute amount of Cs and K sorption depended on the kind of clay mineral and soil. Cesium sorption relative to K was greater in Ca-clay than in H-Al-clay. The concentration of the stable Cs and K present was also an important factor. When the tracer Cs^{137} was diluted to a negligible fraction of the total Cs in solution, only a negligible fraction of Cs^{137} was sorbed. In equimolar mixtures of Cs and K, the sorption of Cs relative to K decreased as the ionic concentration increased. As a corollary to this effect, under conditions of low ionic concentration, stable Cs was much more effec-

tive than K in releasing Cs^{137} from soils. In high concentrations, however, K may be, in certain soils, as effective as stable Cs. (auth)

Radiation Effects on Living Tissues

1234 (AF-SAM-62-51) A STUDY OF THE EFFECT OF INTERMITTENT LOW-LEVEL Co^{60} GAMMA IRRADIATION ON HEMOPOIESIS IN THE MONKEY (MACACA MULATTA). Robert J. Young, Betty J. Joseph, and Richard M. Ritter (School of Aerospace Medicine, Brooks AFB, Tex.). June 1962. 13p.

The effect on hematopoiesis of intercurrent stress imposed immediately preceding radiation was investigated in the monkey. Three groups of Macaca mulatta monkeys were exposed to 200 r, 100 r, and 50 r of whole-body radiation. The irradiation was repeated four times at 80-day intervals. The animals received an additional stress in the form of a phlebotomy (approximately 40 percent of the blood volume being removed) immediately before radiation. A fourth group of animals was phlebotomized and served as nonirradiated controls. The impairment and subsequent recovery of the bone marrow were assessed by means of Fe^{59} uptake and repeated hematograms. (auth)

1235 (NP-12155) ÜBER DIE WIRKUNG DER RONTEGENSTRAHLEN AUF DEN STOFFWECHSEL VON MILCHSAUREBAKTERIEN. (THESE). (Effects of X Rays on the Metabolism in Lactic Acid Bacteria (thesis).) Detlev Kayser (Berlin. Technische Universität). 1961. 91p.

The impact theory of direct and indirect radiation effects is discussed. The cultivation, isolation, and metabolism of the bacteria are described. Radiation effects were determined at different bacteria concentrations, at various oxygen pressures, and with catalase additions. Compensation for irradiation by hydrogen peroxide additions is discussed. (M.C.G.)

1236 (TID-17000) THE EFFECTS OF RADIATION ON THE GENETIC SYSTEM OF ORGANISMS IN RELATION TO THEIR PHYSIOLOGICAL AND BIOCHEMICAL SYSTEMS. Progress Report, May 1, 1957–April 30, 1958. Mary L. Alexander (Texas. Univ., Houston. M. D. Anderson Hospital and Tumor Inst.). Contract AT(40-1)-1828. 17p.

The effects of radiation on the genetic system of organisms in relation to their physiological and biochemical systems were investigated in the immature germ cells of Drosophila virilis. This biological system offers a group of cells composed of spermatogonial cells, meiotic cells, and post-meiotic spermatid and sperm cells. Different amounts and types of biological damage were observed in the different types of cells. Results are presented on the effects of fast neutrons, 200 kv x rays, 1.17- to 1.33-Mev γ rays from a Co^{60} source, and 22-Mev x rays from a betatron source. The relative biological efficiency values for the radiations used were calculated using the rad dose necessary to produce lethals in 50 percent of the cells. Data are tabulated. (C.H.)

1237 (TID-17001) THE EFFECTS OF RADIATIONS ON THE GENETIC SYSTEMS OF ORGANISMS IN RELATION TO THEIR PHYSIOLOGICAL AND BIOCHEMICAL SYSTEMS. Progress Report, May 1, 1958–April 30, 1959. Mary L. Alexander (Texas. Univ., Houston. M. D. Anderson Hospital and Tumor Inst.). Contract AT(40-1)-1828. 24p.

The developing germ cells of Drosophila virilis were used as a biological system for the comparison radiation damage in dividing and several types of non-dividing cells. By utilizing different radiations, cell types, and environmental controls, the variations in radiosensitivity of non-dividing cells were shown to depend both on differences in sensitivity of the chromosomes for breakage and differences in enhancement of biological damage from environmental changes. A differential action upon cells in division and non-dividing cells was shown. Preliminary studies indicate that several lethal actions resulting from treatment of dividing cells can be separated and tested with the various radiations. Data are included on the effects of radiations from fission neutrons, accelerator neutrons, therapy x rays, γ rays from a Co^{60} source, and 22-Mv x rays from a betatron accelerator. Germ cells of varying sensitivities were exposed in an atmosphere of oxygen or nitrogen. Data are presented graphically. Results are included from a study of mutation rates at specific gene loci in mature sperm and spermatogonial cells of Drosophila melanogaster. (C.H.)

1238 (TID-17002) THE EFFECTS OF RADIATIONS ON THE GENETIC SYSTEMS OF ORGANISMS IN RELATION TO THEIR PHYSIOLOGICAL AND BIOCHEMICAL SYSTEMS. Progress Report, May 1, 1959–April 30, 1960. Mary L. Alexander (Texas. Univ., Houston. M. D. Anderson Hospital and Tumor Inst.). Contract AT(40-1)-1828. 20p.

Results are reported from studies on the effects of radiation dose rates on genetic damage in mature sperm and various types of germ cells of the spermatogenic cycle in Drosophila virilis. The cells were exposed to fission neutrons, accelerator neutrons, and ionizing radiations from therapy x rays, γ rays from a Co^{60} source, and 22-Mv x rays from a betatron accelerator in anoxic atmospheres afforded by nitrogen and argon and in gaseous atmospheres containing oxygen. Tests were made for genetic mutations at specific gene loci in sperm and spermatogonial cells. Differences in radiation damage after treatment of mature germ cells and premeiotic spermatogonial cells are discussed. Preliminary results are included from a study of possible mechanisms for retention of radiation induced mutations in gene populations in Drosophila. (C.H.)

1239 (TID-17003) THE EFFECTS OF RADIATIONS ON THE GENETIC SYSTEMS OF ORGANISMS IN RELATION TO THEIR PHYSIOLOGICAL AND BIOCHEMICAL SYSTEMS. Progress Report, May 1, 1960–April 30, 1961. Mary L. Alexander (Texas. Univ., Houston. M. D. Anderson Hospital and Tumor Inst.). Contract AT(40-1)-1828. 15p.

Results are reported from experimental tests for recovery systems that act after radiobiological damage and studies on the types of genetic damage induced and the recovery of mutational types of damage from spermatogonial cells of Drosophila virilis. Dose rate studies with γ rays in anoxic and oxygenated atmospheres were employed in investigations of postirradiation methods for reducing genetic damage. Higher values for dominant lethals were recovered from spermatogonia after irradiations with 22-Mv x rays than with 200-kv x rays. Investigations were made of chromosome breakage, cell degeneration, genetic damage, and mutational studies of sex-linked and autosomal loci. Direct comparisons were made of loci on the sex chromosome and the autosomal loci in sperm and spermatogonial cells. (C.H.)

1240 (TID-17010) EFFECT OF IRRADIATION ON THE NATURE OF DNA AS EVIDENCED BY FRACTIONATION ON ECTEOLA. Helen Harrington (Western Re-

serve Univ., Cleveland). [nd]. Contract [W-31-109-eng-78]. 16p.

Normal and irradiated DNA isolated from Ehrlich ascites tumor cells were adsorbed on columns of ion-exchange cellulose and eluted with solutions of NaCl and NH_4OH of increasing strength. The elution patterns were compared and some of the properties of corresponding control and irradiated fractions were examined. Using a gradient elution some of the irradiated DNA was eluted at a lower pH than in the case of the control DNA. No change was noted in the increase in ultraviolet absorption with increase in temperature between corresponding normal and irradiated fractions. Neither has a significant or consistent change been detected in the sedimentation rate or in viscosity solutions of low and high ionic strength and before and after heating. When DNA was isolated from tumor cells which were allowed to incorporate H^3-thymidine for 1, 4, 9, or 18 hours, all DNA fractions obtained from the cellulose columns contained radioactivity. The specific activities varied, and those fractions which were eluted with 0.5 M NaCl, 1.0 M NaCl, 2 M NaCl – 0.4 N NH_4OH, and 2 M NaCl – 0.5 N NH_4OH were consistently found to have a specific activity higher than the average. Some differences were found between the specific activities of corresponding control and irradiated fractions at various times after injection of H^3-thymidine. (auth)

1241 (TID-17013) INSENSITIVITY TO IONIZING RADIATION OF DNA-POLYMERASE IN A SLIME MOLD. Oddvar F. Nygaard (Western Reserve Univ., Cleveland). [1961]. Contract [W-31-109-eng-78]. 10p.

In the plasmodial slime mold Physarum polycephalum the nuclear divisions are synchronous. Synthesis of DNA occurs very shortly after the division and occupies a relatively brief period of the cell cycle. In contrast to the intermittent occurrence of DNA synthesis the formation of thymidine triphosphate from non-phosphorylated precursors (orotic acid and thymidine) takes place throughout interphase. DNA-polymerase, the enzyme capable of polymerizing deoxynucleoside triphosphates in the presence of primer or template-DNA, has been demonstrated in extracts of molds harvested at any time of the cell cycle. Extracts made from molds irradiated during interphase with 100,000 r of x radiation showed no decrease in polymerase activity as compared with extracts from unirradiated controls. It appears that in Physarum the DNA synthesis is not controlled by variations in the amount of DNA-polymerase and, furthermore that this enzyme is very insensitive to ionizing radiation. (auth)

1242 (TID-17178) LUNG HAZARDS FROM INHALED RADIOACTIVE PARTICULATE MATTER. Progress Report, July 15, 1957 – July 14, 1958. Herman Cember and Joseph A. Watson (Pittsburgh. Univ. Graduate School of Public Health). July 15, 1958. Contract AT(30-1)-912. 43p.

Since pulmonary retention seems to be a critical factor in pulmonary carcinogenesis, the lung clearance rates of several different materials, including a soluble substance ($Ce^{144}Cl_3$) as well as several insoluble particulates ($Hg^{203}S$, $Ba^{133}SO_4$, and $Ce^{144}F_3$), were studied. Phagocytosis is thought to be an important mechanism for removal of dust particles from the lung. In vitro studies, therefore, were carried out to determine whether radioactive particulates are engulfed by phagocytes at a different rate from non-radioactive particulates. In order to recover the radioactive isotope from the particulates, ion exchange methods for recovering sulfur-35 from barium sulfate were investigated. Techniques for measuring the activity levels of isotopes in the blood immediately after intratracheal injection were developed. (N.W.R.)

1243 (AEC-tr-5423) TO THE PROBLEM OF HETEROGENEITY OF CELLS ORIGINATING FROM DIVISION OF A MOTHER CELL. A. Lengerova. Translated by Lydia Venters (Argonne National Lab., Ill.) from Chekhoslov, Biol., 2: No. 1, 18-(1953). 17p.

Data are presented to support an explanation of radiation effects on cells of different size which originate from the division of a single initial cell. Experiments were conducted with beta particles which confirm the assumption that such cells are not equal morphologically or functionally. (J.R.D.)

1244 PATHOGENESIS OF CONTACT ECZEMA. CORTICOIDS AND X RAYS. Lino Businco, Umberto Granelli, Salvatore Bella, Assuero Gaffi, and Corrado Barocci (Ospedale San Gallicano, Rome). Acta Allergol., 16: 366-8(1961). (In French)

Biopsied samples of skin from patients with allergic dermatitis treated with corticosteroids showed, upon microscopic examination, that the treatment reduced the number of perivascular inflammatory cells. Diminution of these cells paralleled clinical improvement, and cessation of steroid therapy caused reappearance of eczema. Similar histopathologic results were seen in cases of contact dermatitis treated with x rays. After irradiation the perivascular inflammatory cells showed degeneration, leaving large amounts of nuclear debris, followed by proliferation of fibroblasts. The abnormally thickened and multistratified epidermis became thinner and more normal in appearance. The beneficial effects of corticosteroids and radiation were practically identical and it is suggested that both acted by destroying perivascular antibody-forming cells. (H.H.D.)

1245 ON THE INDUCED INCREASED RESISTANCE OF BACTERIA AGAINST CONVENTIONAL ROENTGEN IRRADIATION. Ragna Rathsack and Wolfgang Brucker (Deutschen Akademie der Wissenschaften, Berlin). Acta Biol. Med. Ger., 8: 547-58(1962). (In German)

For the purpose of producing radioresistant strains, cultures of Aqrobacterium tumefaciens were irradiated 3 times weekly with 300 kr/week up to a total dose of 7800 kr. The irradiated bacteria showed a slower rate of growth up to the 3rd day after subculture, but by the 4th day bacterial counts were the same in irradiated and control cultures. Irradiation with 50 kr had no effect on the growth rate although it was lethal to 80 to 85% of the cells, and 100 kr only slightly inhibited growth. The growth inhibition in irradiated cultures was more evident when they were transferred to a different culture medium. Bacteria irradiated with a total of 2500 to 4500 r had only low virulence, i.e., attenuated ability to induce crown-gall tumors in tomato plants, and lowered virulence could even be detected after single doses of 50 or 100 kr. Attempts to produce a radioresistant strain of this bacterium were not successful. (H.H.D.)

1246 OXIDATIVE PHOSPHORYLATION AFTER IRRADIATION OF RADIOSENSITIVE ORGANS. H.-J. Altenbrunn and E. Kobbert (Forschungsgemeinschaft der Deutsche Akademie der Wissenschaften, Berlin). Acta Biol. Med. Ger., 9: 25-38(1962). (In German)

Mitochondrial fractions were prepared from spleen, testis, liver, and kidney of rats. The utilization of O and inorganic P and the P/O ratio were determined in isolated mitochondria incubated in the presence of succinate or α-ketoglutarate. In spleen and testis mitochondria, unlike

liver and kidney mitochondria, the P/O ratio fell immediately but could be restored temporarily by addition of coenzyme (diphosphopyridine nucleotide). After 2-hr storage at 0°, oxidative phosphorylation became partially uncoupled and could not be restored by coenzyme. Immediately after irradiation of isolated mitochondria with 200-kv x rays at doses up to 40,000 r, respiration and phosphorylation were unaffected. However, at subsequent intervals spleen mitochondria showed changes resembling those seen after storage. Spleen and testis mitochondria isolated 24 hr after irradiation of rats with 2500 r showed a 30% decrease in phosphorylation and a 20% decrease in respiration. (H.H.D.)

1247 RADIOACTIVE PHOSPHORUS AND FERTILITY. E. A. D. Holmberg, A. Pavlovsky, E. Arini, C. D. Pasqualini, and S. L. Rabasa (National Academy of Medicine, Buenos Aires). Acta Physiol. Latinoam., 11: 249-50(1962). (In English)

The effect of P^{32} on the gonads of BALB mice was studied. The ovary is more sensitive to P^{32} than the testes since a dose of 40 μc induces sterility in the female, while all males surviving doses of P^{32} up to 205 μc remain fertile. These animals were tested for fertility before the injection of P^{32} and were mated afterwards during periods of 5 to 12 months. The histologic pattern of the ovaries shows generalized luteinization without the presence of primordial follicles. Testes show no alterations. Females injected with P^{32} during pregnancy remain fertile after doses of 40 to 60 μc, and only after 90 μc became sterile; this represents more than twice the sterilizing dose for a nonpregnant female. Progesterone given at a dose of 2 mg per week during 4 weeks before P^{32}, and 2 weeks after, affords some protection, but it is not as complete as that afforded by pregnancy. (H.H.D.)

1248 HISTOCHEMICAL CHANGES PRODUCED BY HIGH DOSES OF X RAYS IN THE HEAD OF YOUNG RATS. R. L. Cabrini, F. Schajowicz, and F. A. H. Carranza (Comisión Nacional de Energía Atómica, Buenos Aires). Acta Physiol. Latinoam., 11: 280-1(1961). (In Spanish)

The head of 1- to 7-day-old rats was irradiated with a single dose of 16,000 r, the rest of the body being shielded, and at subsequent daily intervals histochemical tests were made in skin, oral mucosa, and bone-forming structures. From the 1st postirradiation day changes could be noted in glycogen, alkaline phosphatase, and especially in cytoplasmic basophilia. (H.H.D.)

1249 ACTION OF X RAYS IN DIFFERENT PERIODS OF THE HAIR CYCLE IN CASTRATED C3H MICE. C. E. Epper, A. N. Houssay, and E. I. Saurer (Comisión Nacional de Energía Atómica, Buenos Aires). Acta Physiol. Latinoam, 11: 281(1961). (In English)

Since in several pure strains of mice the histologic structure of hair follicles of the skin undergoes changes after castration, gonadectomized mice were used to study the effect of irradiation. Total or partial irradiation with 200 rad 1 day after castration (hair follicles in telogen phase) causes a slight loss in pigment and a dose of 400 rad produces, besides a marked loss in pigment, a significant delay in hair growth. In animals irradiated with 200 or 400 rad 6 or 11 days after castration (hair follicles in anagen phase 2 or 6) there was no difference from control animals. Partial irradiation with 800 or 1200 rad 1 day after castration causes an intense loss of pigment and a marked delay in hair growth. When partial irradiation is performed 6 days after castration the effects are less evident, whereas if the same doses are applied 11 days after castration only the 1200-rad dose elicits visible effects. This experiment demonstrates the variation in radiosensitivity according to the phase of the hair cycle induced by gonadectomy. (H.H.D.)

1250 A STUDY WITH Fe^{59} OF THE ERYTHROPOIETIC EFFECT OF THE PLASMA OF RATS IRRADIATED AND MADE ANEMIC WITH PHENYLHYDRAZINE. I. Eskuche. Acta Physiol. Latinoam., 11: 305(1961). (In Spanish)

Rats exposed to 550 r gamma irradiation and treated with phenylhydrazine developed severe anemia (< 3 g hemoglobin per 100 ml blood) within 2 weeks. During the period of maximum anemia the plasma of these rats contained a high level of erythropoietin (> 20 units per ml). The erythropoietic activity of this plasma is linearly related to the degree of anemia at hemoglobin levels below 7 g per 100 ml. Radiation alone produced only a slight anemia (9 g hemoglobin per 100 ml) in rats, and their plasma showed no erythropoietic activity. In experiments utilizing Fe^{59} to follow erythropoiesis after injection of recipient rats with plasma from irradiated rats with hemolytic anemia, a biphasic response was noted, incorporation of Fe^{59} showing maxima at 18 and 48 hr after injection of this plasma. This was interpreted as demonstrating that this plasma stimulates hemoglobin synthesis, as shown by the early increase in Fe^{59} uptake, as well as promotes maturation of erythroblasts, as shown by the late phase at 48 hr. (H.H.D.)

1251 ROENTGEN IRRADIATION OF THE MALE BREAST. L.-G. Larsson and C.-M. Sundbom (Umea Medical School, Sweden). Acta Radiol., 58: 253-6(Aug. 1962). (In English)

The effect of roentgen irradiation of the male breast was studied in subjects with carcinoma of the prostate. The therapy appeared effectively to inhibit the hyperplasia of the breast that usually occurs during treatment with estrogenic hormones. (auth)

1252 CHANGES IN PERIPHERAL NERVE TISSUE AFTER IRRADIATION WITH HIGH ENERGY PROTONS. R. Bergstroem (Univ. of Uppsala). Acta Radiol., 58: 301-12(Aug. 1962). (In English)

An investigation of the effect of proton irradiation on the sciatic nerve of the rat with reference to the time of appearance of paresis for different doses and beam widths, the histologic alterations in the nerves before and during the development of paresis, and the stages of healing is reported. The changes at intervals following the irradiation are described in detail. The findings are discussed against the background of earlier experiments on the effect of high energy protons on the central nervous system in the rabbit. (auth)

1253 UNITS IN RADIATION MEASUREMENTS. DISCUSSION OF DEFINITIONS. H. R. Schinz and R. Wideroee (Universität, Zurich). Acta Radiol., 58: 313-20(Aug. 1962). (In English)

In radiation measurements, measurement of the radiation field, radiometry, must be distinguished from the measurement of the dosage field in a body, dosimetry. For the purpose of determining clear definitions, the absorption of the radiation in free air is ignored and the concept of dose is therefore limited only to an absorbing body. The practical unit of measurement for radiometry is the roentgen which corresponds to the radiation density of the field. The unit employed in dosimetry is the rad, and the roentgen should not be used here. The rho is an auxiliary unit used in ionization measurements from which the dose in rads is determined. Rho is used for the measurement and rad for the dosage of radiation. An example is given to show how closely these two disciplines are connected in practice, i.e. in radiation protective measurements. (auth)

1254 EFFECTS OF ANESTHESIA ON IRRADIATED ANIMALS. Torrence M. Young, S. A. Allan Carson, Joseph Mezistrano, and Lucien E. Morris (Univ. of Washington, Seattle). Anesthesiology, 23: 74-80(Jan.-Feb. 1962).

The relative influences of various anesthetics were investigated in mice and rats given whole-body irradiation of 200-1100 and 600-750 r respectively. The LD_{50} of radiation was 650 r in mice and ~700 r in rats. The 30-day mortality in rats was 0% at 625 and 650 r; 40% at 675 r, and 100% at 750 r. All of the anesthetic agents tested increased the mortality or morbidity, depending on the radiation dose. Chloroform and trifluoroethyl vinyl ether was most detrimental, halothane was least injurious, whereas cyclopropane and ethyl ether showed intermediate toxicity in irradiated animals. Hypercarbia and hypoxia developing during anesthesia did not appear to enhance mortality or morbidity following irradiation; however, burns (dipping rats in water at 62°C for 5 min) enhanced these effects in anesthetized-irradiated animals. Intravenous injection of lidocaine produced a higher mortality when carried out within a few hours after irradiation than 3 days later. It is concluded that halothane is the most satisfactory anesthetic agent following irradiation and that it is best given 24 hr or later after exposure. (H.H.D.)

1255 IRRADIATION OF OVARIAN GRAFTS. ACTION OF VARIOUS DOSES OF X RAYS ON THE SUCCESS OF INTERRACIAL BREPHOPLASTIC GRAFTS OF OVARIES IN MICE. Janine Thimothee and Raoul Michel May (Faculté des Sciences, Paris). Ann. Endocrinol. (Paris), 23: 201-2(Mar.-Apr. 1962).

Ovaries of newborn mice were grafted to the anterior chamber of the eye of castrated adult mice of the same strain as the donors. These ovarian grafts in female recipients successively developed follicles and corpora lutea; however, such grafts in males formed follicles but not corpora lutea. In contrast to these results with isologous grafts, different results were obtained with homologous grafts. When ovaries of newborn albino (Swiss) mice were transplanted to the eye of black (C57B1) castrate female mice, lymphocytic invasion of the graft occurred within a few days and it degenerated. The effect of irradiation of these recipients with 300 to 1350 r 2 days before transplantation was investigated. Doses of 600 to 1000 r allowed such grafts to develop up to the stage of forming follicles, but they did not form corpora lutea and degenerated after the 35th day. (H.H.D.)

1256 ACTION OF X RAYS ON ANTIBODY FORMATION FOLLOWING AN INJECTION OF A SINGLE ANTIGEN. J. Loiseleur and M. Petit (Institut Pasteur, Paris). Ann. Inst. Pasteur, 103: 54-8(July 1962).

Rabbits were irradiated with 100 to 900 r at various intervals (1 to 48 hr) before or after intravenous injection of ovalbumin, and serum antibody titers were determined 4 days after the injection. A dose of 600 r given 5 to 8 hr before antigen completely prevented the appearance of detectable antibody levels, whereas the same dose 16 to 24 hr before antigen allowed some antibody to be formed but to lower levels than in nonirradiated controls. It is suggested that in the longer interval between irradiation and antigen injection some antibody-forming lymphocytes had regenerated. Low x-ray doses (100 and 200 r) administered 6 hr before antibody actually gave a higher antibody response than in nonirradiated controls, but higher doses (300 to 900 r) given at this time inhibited the response, it being nil after doses above 500 r. No antibody could be detected when 600 r was given 1 to 48 hr after antigen injection, but with 300 r a slight response was noted if it was given 48 hr after antigen. (H.H.D.)

1257 STUDY OF THE MITOTIC INDEX AND OF SOME MEDULLARY ELEMENTS IN FIVE SUBJECTS EXPOSED TO WHOLE-BODY RADIATION THERAPY. S. Davidoff-Alibert, J. Dormont, H. Jammet, N. C. Parmentier, and M. Tubiana (Commissariat à l'Energie Atomique, Saclay, France). Ann. Radiol., 5: 499-513(1962). (In French)

The mitotic index of the marrow in five subjects receiving whole-body therapeutic irradiation in a uniform dose was followed up by repeated marrow puncture. In two patients who received 400 and 450 rads, the mitotic index fell little up to the 20th day, and then fell to zero. It then rose rapidly again to a value above normal. This was accompanied by a rapid increase in the number of blood cells in the peripheral blood. In patients who received 100 and 250 rads, the evolution took place in three phases: an initial fall of the mitotic index, a transitory rise, and then a second fall. The rise in the number of blood cells occurred during a phase in which the marrow was aplastic. In the patient who received 50 rads, only a slight and late variation of the mitotic index was observed. The higher the dose, the earlier is the blood aplasia and the earlier the marrow and blood regeneration. (auth)

1258 THE ACTION OF ANTERIOR PITUITARY TRANSPLANTS ON THE WEIGHT AND THE FUNCTION OF ADRENAL GLANDS OF HYPOPHYSECTOMIZED RATS. EFFECTS OF X IRRADIATION. P. N. Martinovitch, Z. M. Bacq, D. Pavitch, and D. Simitch-Sladitch (Inst. Boris Kidrich, Belgrade). Arch. Intern. Physiol. Biochim., 69: 9-18 (Feb. 1961). (In English)

Male, 100-g rats were hypophysectomized and grafted with 6-10 anterior pituitaries from 20-day-old rats. Evidence for secretory activity of these transplanted glands is cited. The atrophic adrenal glands of the recipients partially recovered their normal weight. Stress, in the form of lethal 850-r whole-body irradiation, caused a marked drop in adrenal cholesterol content 3 hr later. After removal of the pituitary transplants irradiation produced no change in adrenal cholesterol, and adrenal weight fell to that of hypophysectomized controls not receiving transplants. (H.H.D.)

1259 TOTAL IRRADIATION AND ADRENAL ACTIVITY. W. Eechaute, G. Demeester, and I. Leusen (Université, Ghent). Arch. Intern. Physiol. Biochim., 69: 109-12(Feb. 1961). (In French)

The influence of 750-r whole-body irradiation on adrenocortical activity was investigated in adult male rats by following changes in plasma corticosteroid levels. The level was increased 2½ hr after irradiation, became normalized by the 24th hr, then rose again on the third day. The level was especially high in moribund animals. In vitro studies of hormone synthesis in slices of adrenals removed at these times confirmed this biphasic response. The initial rise in adrenocortical activity was not accompanied by an increase in adrenal weight, but in the 2nd rise this weight increased although the production of corticoids per mg gland did not increase. It is suggested that the higher level of plasma corticoids after irradiation may result from their diminished catabolism by the injured liver, as well as from diminished secretion by the adrenals. (H.H.D.)

1260 ACTION OF CYSTEAMINE AND CYSTAMINE ON METABOLISM IN THE LIVER AND KIDNEY OF MALE RATS POISONED WITH SODIUM FLUOROACETATE. Andre Van de Berg (Université, Liege). Arch. Intern. Physiol. Biochim., 69: 235-50(Mar. 1961). (In French)

Hepatic and renal levels of citrate were followed in rats poisoned with fluoroacetate and injected intraperitoneally with the radioprotective agents cysteamine (10 mg/100 g) or cystamine (12 mg/100 g). Hepatic citrate level was also followed in rats irradiated with 800 to 850 r and injected with cysteamine before or after irradiation. The accumulation of citrate in kidney induced by fluoroacetate was diminished by pretreatment with cysteamine, but its effect on the kidney may be caused by the circulatory changes it produces. Cystamine was similarly effective in reducing renal citrate. Cysteamine, but not cystamine, increased liver citrate levels, thus appeared to aggravate the action of the poison on liver cells. Cystamine, but not cysteamine, diminished hepatic citrate when given before or after irradiation and injection of fluoroacetate. Cystamine, but not cysteamine, augmented the ability of rats to acetylate sulfanilamide. The results show that these 2 compounds may have quite different effects. They may protect against fluoroacetate poisoning by modifying the distribution of coenzyme A or indirectly by altering hormone secretion, since citrate accumulation is influenced by castration and adrenalectomy. (H.H.D.)

1261 INFLUENCE OF CYSTEAMINE ON THE RENAL CITRIC ACID LEVEL IN THE MALE RAT IRRADIATED AND POISONED WITH SODIUM FLUOROACETATE. Andre Van de Berg (Université, Liege). Arch. Intern. Physiol. Biochem., 69: 251-9(Mar. 1961). (In French)

In rats poisoned with fluoroacetate, injection of radioprotective doses (12 mg/100 g) of cysteamine 15 min later depressed the accumulation of citrate in kidney caused by this poison. However, if given 12 hr later the effect of the poison is not modified. Irradiation of the rats with 800 r diminished the rise in renal citrate caused by fluoroacetate, and this effect of irradiation is accentuated by injection of cysteamine 3 min before or 15 min after irradiation. Renal citrate level of rats poisoned 24 hr after irradiation was lower than in nonirradiated rats and cysteamine enhanced this effect of irradiation. The action of cysteamine on renal citrate was not evident before 48 hr after irradiation when it was injected before or after irradiation. Cysteamine was radioprotective only if injected 3 min before irradiation and when there was a 72-hr delay between irradiation and fluoroacetate treatment. (H.H.D.)

1262 EFFECTS OF X IRRADIATION ON THE LEVEL OF NUCLEIC ACIDS AND PROTEINS OF THE UTERUS AND VAGINA OF PREPUBERTAL MICE SUBMITTED TO INDUCED HYPERPLASIA. L. Ledoux and P. Charles (Centre d'Étude de l'Energie Nucléaire, Mol, Belg.). Arch. Intern. Physiol. Biochim., 69: 751-2(Dec. 1961). (In French)

In 20-day-old mice injected subcutaneously with a single 10 ug. dose of estradiol benzoate the deoxyribonucleic acid (DNA) content rose 100% in uterus and 50% in vagina 72 hr later. Ribonucleic acid (RNA) content rose 250 and 100%, respectively, and protein content rose in parallel with DNA. Similarly treated mice were exposed to x rays (150 to 850 r) 24 hr before, simultaneously with, or 24 to 48 hr after injection of estradiol. Irradiation with 750 r before or with the injection inhibited the rise of DNA and RNA 50 to 80% but did not affect the increase in proteins. Irradiation of uninjected control mice diminished DNA and RNA. Irradiation 24 to 48 hr after the injection immediately suppressed the increases of DNA and RNA in uterus and vagina and of protein in uterus. Protein content of vagina was not influenced. (H.H.D.)

1263 CORRELATION OF BACTERIAL RADIOSENSITIVITY AND DNA BASE COMPOSITION. Henry S. Kaplan and Richard Zavarine (Stanford Univ., Palo Alto, Calif.). Biochem. Biophys. Research Communs., 8: 432-6(Aug. 31, 1962).

Several bacterial species known to exhibit a wide range of desoxyribonucleic acid (DNA) base composition were studied with respect to x ray and ultraviolet sensitivity. Dose-log survival curves were obtained from Escherichia coli, Pseudomonas aeruginosa, micrococcus pyogenes, Bacillus subtilis, Bacillus cereus, and Serratia marcescens exposed to x radiation under closely controlled pre- and postirradiation culture conditions. Limited ultraviolet radiation exposures were also carried out. Survival was calculated from the colony counts at each dose level as a fraction of the colony counts of an unirradiated aliquot. Results were compared with data on the guanine-cytosine content of each species. It was concluded that a correlation exists between x ray sensitivity and DNA base composition of these bacterial species under aerobic and anaerobic conditions. (C.H.)

1264 INHIBITION OF SODIUM PUMP AND INCREASE OF PASSIVE FLUXES BY X-RAYS IN HUMAN ERYTHROCYTES. F. Bresciani, F. Auricchio, and C. Fiore (Università, Naples). Biochem. Biophys. Research Communs., 8: 492-6(Aug. 31, 1962).

X irradiation induces an increase of Na and a decrease of K content in erythrocytes. Results are reported from studies on the mechanisms that produce this effect. It was concluded that x radiation interferes with the biochemical mechanism of the active extrusion of Na through the cell membrane, but has only a slight effect on passive fluxes. (C.H.)

1265 COLLAGEN IN IRRADIATED MUSCLE. M. Bottero, R. Vecchioni, V. Gallucci, and C. Ruffato (Università, Padua). Boll. Soc. Ital. Biol. Sper., 38: 484-6(May 31, 1962).

A dose of 2185 rad was applied to a 2 × 5 cm area of the hind leg of male rats, and 3 to 30 days later the gastrocnemius muscle was removed. Muscle collagen was then fractionated by the method of Jackson (Biochem. J., 65: 277 (1957)) into neutral-salt soluble, acid soluble, and insoluble fractions. From the 3rd day after irradiation the neutral-salt soluble fraction declined, reaching a min level 50% below normal by the 9th day. Thereafter it rose, regaining the initial level by the 30th day. The acid soluble and insoluble fractions showed only a slight decline beginning on the 15th day after irradiation. The results indicate that the synthesis of muscle collagen is depressed for several weeks after irradiation, then rapidly recovers. (H.H.D.)

1266 COLLAGEN IN IRRADIATED BLADDER. C. Ruffato, V. Gallucci, R. Vecchioni, and M. Bottero (Università, Padua). Boll. Soc. Ital. Biol. Sper., 38: 486-8 (May 31, 1962).

These studies were prompted by previous observations of injury to the connective tissue in the urinary bladder of women with uterine cancer treated with x rays or Ra. Adult rats were irradiated with a single dose of 1800 r in the abdominal region, over an area of 2 × 3 cm, the rest of the body being shielded. At intervals, 6 to 30 days later, the urinary bladder was removed and its collagen was fractionated into neutral-salt soluble, acid soluble, and insoluble fractions. Total and insoluble collagen were lower in irradiated bladders and both fractions progressively decreased from the 6th to the 30th day after irradiation. The collagen fraction soluble in neutral salt was higher on the 6th day and the acid soluble fraction was higher on the 30th day after irradiation than in control bladder. The results indicate that irradiation retards the maturation of collagen from soluble to insoluble, fibrous form. (H.H.D.)

1267 THE FATE OF LETHALLY IRRADIATED MICE GIVEN ISOLOGOUS AND HETEROLOGOUS THORACIC DUCT LYMPHOCYTES. B. M. Gesner and J. L. Gowans (Sir William Dunn School of Pathology, Oxford). Brit. J. Exptl. Pathol., 43: 431-40(Aug. 1962).

Lethally x irradiated (1000 rad) mice of a highly inbred strain (CBA) were injected with large numbers of isologous thoracic duct cells. The survival time of the animals was recorded and their tissues were examined for the presence of proliferating marrow cells. Intravenous injection of 8 to 18.8×10^7 lymphocytes did not reduce the mortality from radiation, nor did it lead to any hematopoiesis in spleen or bone marrow. However, it restored the ability of lethally irradiated mice to reject a graft of rat bone marrow. Lethally irradiated mice which received rat thoracic duct lymphocytes died earlier than untreated controls or mice receiving isologous lymphocytes. An injection of rat lymphocytes also eliminated the beneficial effect of treatment with isologous bone marrow. These reactions of lethally irradiated mice were accompanied by the appearance and proliferation in the splenic white pulp of large cells with an intensely pyroninophilic cytoplasm, a pale nucleus, and a prominent nucleolus. These cells probably developed from the injected lymphocytes. The experiments do not support the idea that lymphocytes can transform into marrow stem cells, but they illustrate the immunological activity of lymphocytes. These findings are at variance with those of Delorme (Lancet, 2: 855(1961)), who found that isologous thoracic duct cells protected 43% of rats against a lethal dose of x irradiation. This discrepancy is probably due to differences in the sensitivity of mouse and rat tissues to x irradiation. (H.H.D.)

1268 THE PROBLEM OF OVER-IRRADIATION. B. W. Franklin Bishop. Brit. J. Plastic Surg., 13: 354-71(1961).

The destructive effects of high dosage radiotherapy in carcinoma patients are discussed in relation to the apparently increasing need for plastic surgery in such irradiated patients. To avoid unnecessary damage, it is suggested that benign conditions, such as dermatitis and warts, not be treated by radiotherapy. In the experience of the author, radiotherapy in a large proportion of cases has been grossly destructive and the doses used have been far above the safety level. In cases in which x-ray treatments have arrested the primary lesion, the result has been cosmetically unacceptable, and plastic surgery necessary. In the author's opinion, irradiation should not be used for surface malignancies. A number of cases are cited in which irradiation of benign lesions has been followed by malignant changes. (H.H.D.)

1269 THE EFFECT OF RADIATION ON SPERMATOGENIC CELLS IN THE RAT AND MOUSE. Margaret Partington, A. W. Craig, and H. Jackson (Christie Hospital, Withington, Manchester, Eng.). Brit. J. Radiol., 35: 713-18(Oct. 1962).

The quantitative histological changes in the seminiferous epithelium of the rat and mouse after whole-body irradiation are compared. Dose levels of 100 and 300 r were used. In the rat there was no direct action on Type B spermatogonia, even at 300 r, although the LD_{50} for this cell stage in the mouse was 20 to 25 r. In both species there was a marked reduction in the number of Type A spermatogonia, but a proportion of these cells were radioresistant. The significance of these results is discussed. (auth)

1270 PRODUCTS OF THE NEWER ALCHEMY. THE SILVANUS THOMPSON MEMORIAL LECTURE. W. P. Grove (Radiochemical Centre, Amersham, Bucks, Eng.). Brit. J. Radiol., 35: 725-35(Nov. 1962).

Applications of artificial sources of radiation in medicine are reviewed. It is pointed out that of the approximately 1,000 radioactive isotopes of elements up to atomic number 92 identified in the nuclear tables, some 600 are potentially useful in medicine in the sense that they have moderately long half-lives. The number of radioisotopes now available from commercial suppliers exceeds 150, and these can be supplemented by many shorter-lived ones if they can be used close to the center of production. Radiation sources for therapy, the use of radiation sources for the sterilization of pharmaceuticals and medical supplies, applications of radioisotopes in diagnosis, and the administration of radioisotopes in pharmaceutical chemicals and alone in the treatment of certain diseases are discussed. (C.H.)

1271 INSTRUMENTAL AND TECHNICAL NOTES. ROUTINE CALIBRATION OF DIAGNOSTIC X-RAY MACHINES. S. M. Bull and T. E. Burlin (Hammersmith Hospital, London). Brit. J. Radiol., 35: 796-7(Nov. 1962).

The need for the routine calibration of diagnostic x-ray machines to detect any alteration of the machine's performance is stressed. A simple and rapid procedure is outlined. (C.H.)

1272 INVESTIGATIONS ON THE EMBRYONIC MOUSE LUNG CULTIVATED IN VITRO AND IRRADIATED WITH GAMMA-RAYS. T. Alescio and M. Ladu (Comité National pour l'Énergie Nucléaire, Frascati, Italy). Bull. Assoc. Anat., [47: 57-61(Mar. 1961)]. (RT/BIO(62)38). (In French)

Preliminary results on the effects of Co^{60} gamma rays on the embryonic mouse lung developing in vitro are reported. The development of the bronchial tree progressed rapidly in the unirradiated control cultures. The effect of the irradiation was the appearance of an early epithelial degeneration. The epithelial degeneration started from the tracheal epithelium and then spread distally towards the terminal buds. The degeneration process was accompanied by a complete arrest of the branching process. (auth)

1273 INFLUENCE OF X RAYS ON THE DEVELOPMENT OF MELANOTIC TUMORS IN DROSOPHILA (DROSOPHILA MELANOGASTER). QUANTITATIVE STUDY. S. Ghélélovitch (Institut Pasteur, Paris). Bull. Assoc. Franc. Etude Cancer, 48: 151-73(1961).

Irradiation of the embryos or larvae considerably increases the incidence of melanotic tumors in these flies. Irradiation of germinal cells does not influence development of tumors in flies developing from the cells. The presence of the tumor gene in the genotype of the egg or larva is an essential condition for the tumorigenic action of irradiation. The statistical distribution of tumors in irradiated populations conforms to Poisson's law, and it is independent of the stage of ontogenesis at the time of irradiation. The effects of several irradiation treatments are additive, and the incidence of tumors increases with the dose to an upper limit of 600 to 800 r. Beyond 1200 to 1500 r the incidence of tumors decreases as mortality increases. Between doses of 0 and 600 r the incidence of tumors rises linearly from 10% to 95%, respectively. In contrast, the slope of the curve of induction of tumors depends neither on the incidence nor on the level of tumor gene; it seems to be influenced by cytoplasmic and maternal factors. When irradiation increases the number of tumors, it simultaneously increases their size and rapidity of their appearance. Irradiation does not modify the histologic appearance of the tumors. Occasionally tumors were observed in the leucopoietic tissue of the larva. The phago-

cytic activity of blood cells was not affected by irradiation. The increased incidence of tumors in irradiated Drosophila cannot be attributed to selective mortality or to inhibition of defense factors against tumor cells. The failure of irradiation to have a tumorigenic effect in older larvae indicates that it does not affect the development and growth of tumors once formed. It is suggested that irradiation increases the sensitivity of larval cells to a tumor-inducing agent controlled by the tumor gene. A single dose of ultraviolet radiation did not influence tumorigenesis in Drosophila. (H.H.D.)

1274 A STUDY OF THE RADIOSENSITIVITY OF THE ATYPICAL T8 EPITHELIOMA IN THE RAT. J. Jacquet, P. Jacob, S. Abbatucci, and G. Letourneur (Laboratoire de Microbiologie, Faculté des Sciences, Caen, France). Bull. Assoc. Franc. Etude Cancer, 48: 412-20(1961).

The tumors were transplanted to recipient rats and irradiated daily for 10 days with 115 to 480 r/day (at the surface). Irradiation was confined to an area 4.5 cm in diameter, and the total dose varied from 1150 to 4800 r. The tumors, 1 mm in diameter and implanted subcutaneously, grew rapidly and metastasized quickly via the lymphatic system in nonirradiated animals. By the time of irradiation on the 8th to 12th day the tumors were 10 to 40 mm in size and local lymphatic metastases were noted by the 15th to 20th day and death by the 30th to 60th day. Irradiation at the high dose caused complete disappearance of the primary tumor in some cases and reduced the mean weight of the tumor at death to 2 g compared with a mean weight of 43 g in nonirradiated controls. Survival time at the 4800-r dose level was increased to a mean of 52 days compared with 35 in controls; the respective mortality rates were 76 and 100%, and the weight of metastases 11.9 and 8.9 g. The higher weight of metastases in irradiated rats is attributed to their longer survival time. (H.H.D.)

1275 COBALT THERAPY AND PLASMA PROTEINS IN CANCER PATIENTS. P. Marquès, L. Douste-Blazy, and O. de Mauregard (Centre Régional Anticancéreux, Toulouse). Bull. Assoc. Franc. Etudes Cancer, 48: 421-35(1961).

Changes in plasma protein fractions are described in 100 patients whose tumors were irradiated with Co^{60}. These fractions were determined before, at the midpoint of therapy (after 3000 to 5000 r), and following completion of therapy (after 6000 to 12,000 r). The most pronounced change before treatment was the increase in α-globulin and in glycoproteins, especially the α fraction. Albumin was diminished in the cancer patients before therapy. After treatment an improvement in the plasma protein pattern was noted in most cases, including a rise in albumin and a fall in α-globulins and glycoproteins. Irradiation had no significant effect on β- and γ-globulins. The fall in α-glycoproteins occurred more rapidly than that of α-globulins in general. The resorcinol index of Verne, which was initially elevated, fell after treatment but more slowly than α-glubolins. It is suggested that the plasma protein pattern changes after radiation therapy may have diagnostic and prognostic significance. (H.H.D.)

1276 INFLUENCE OF AGE AND STRAIN OF X-IRRADIATED MICE ON THE APPEARANCE OF LEUKEMIA AND LYMPHOID TUMORS. M. R. Rivière, I. Chourolinkov, C. Marty, and M. Guérin (Institut de Recherches Scientifiques sur le Cancer, Villejuif, France). Bull. Assoc. Franc. Etudes Cancer, 49: 100-12(1962).

A single 300-r whole-body dose was given to mice of 3 strains (C3H, IC, XLII) and of 2 age groups (4-6 weeks and 4-6 months). Both age and strain influenced the incidence of leukemia and lymphoid tumors following irradiation. The incidence was higher in young than old mice; the XLII strain was resistant and the IC strain relatively susceptible. The incidence of leukemia or lymphosarcoma in young and old mice, respectively, was 12.2 and 6.8% in the IC strain, 0 and 2.6% in the C3H strain, and 0 and 0% in the XLII strain. The respective incidences in control animals were 4.1, 2; 0, 0; 0, 0%. The lymphosarcomas were most often mediastinal in location. By injection of an extract prepared from lymphomas of AKR mice, combined with irradiation, leukemia or lymphosarcoma could be induced in the resistant XLII stain. Young and old rats developed malignancy in 6.8 and 3.1%, but lymphoma extract alone had no effect. (H.H.D.)

1277 THE USE OF GAMMA RADIATION FOR THE PREPARATION OF VIRUS VACCINES. John R. Polley (Dept. of Health and Welfare, Ottawa). Can. J. Microbiol., 8: 455-9(Aug. 1962).

Suspensions of the viruses (mumps, influenza A (PR8), A_1 (FM_1), B, and swine influenza A) were irradiated in a Co^{60} cell with a dose of 1.5×10^6 rad, which is about 50% higher than the dose calculated to be required for inactivation. A protective agent such as histidine or Na p-aminohippurate was added to purified suspensions of influenza and mumps viruses. It was then possible to inactivate them while retaining most of the hemagglutination titer. It was demonstrated in mice that a vaccine prepared from a mouse-adapted virus (Shope's swine influenza) conferred protection against challenge by the live virus and produced an antibody response as measured by the hemagglutination-inhibition technique. Vaccines prepared with the viruses of influenza A(PR8), influenza B, and mumps were shown to produce antibody responses in guinea pigs as measured by the hemagglutination-inhibition and serum neutralization techniques. The use of gamma irradiation has an advantage over most chemical procedures because its dosage of inactivation can be more accurately controlled. (H.H.D.)

1278 RADIATION RESISTANCE DEVELOPMENT BY ESCHERICHIA COLI. I. E. Erdman and F. S. Thatcher (Dept. of National Health and Welfare, Ottawa). Can. J. Public Health, 53: 36(Jan. 1962).

During multiple exposures to a Co^{60} source the resistance of E. coli to radiation increased 13-fold, the survival curve changing from a linear to a convex form. Except for an increased number of cells at the stationary phase, growth curves showed no change initially, but as resistance developed the lag phase lengthened and the number of cells in the stationary phase dropped. The resistant cells showed a loss of gas production from carbohydrate substrates and loss of ability to form indole from tryptophan. Highly resistant cells showed a high incidence of elongation, increased numbers of nuclear bodies, and development of coccoid buds. (H.H.D.)

1279 THE SOMATIC EFFECTS OF RADIATION. R. M. Taylor (National Cancer Inst. of Canada, Toronto). Can. Med. Assoc. J., 86: 521-6(Mar. 24, 1962).

Effects of radiation in man are reviewed, including induction of leukemia and cancer of skin, thyroid, bone, and lung; cataract; dermatitis; pneumonitis; nephritis; and sterility. The present levels of radiation from fallout in Canada contribute a negligible amount to the total radiation exposure of the population and do not now constitute a significant hazard. (H.H.D.)

1280 ON THE HYPERPIGMENTATION CAUSED BY X RAYS IN THE GUINEA PIG. A. Maggiora (Clinique Universitaire de Dermatologie, Geneva). Dermatologica, 123: 100-5(1961). (In French)

Doses of x rays of 50 to 800 r were delivered to an area of guinea pig skin 3 cm in diameter to determine the threshold radiation dose to induce hyperpigmentation of skin. Hyperpigmentation was noted after 100-r but not 50-r doses, indicating that the threshold lies between 50 and 100 r. Hyperpigmentation appeared to be intensified at doses above 300 or 400 r. It appeared between the 8th and 11th day after irradiation and reached max. development after 24 hr, after which its intensity remained constant for 15 to 30 days. Normal skin color returned in 40 to 60 days; by then the skin color could not be distinguished from that of nonirradiated skin. The time of appearance and intensity of hyperpigmentation showed no relation to the quality of x rays used, over the range of 10 to 70 kv. When the min. effective dose, 100 r, was given in two 50-r doses 1 day apart, no hyperpigmentation of skin resulted, indicating that fractional doses are not as effective as a single dose in inducing this condition. (H.H.D.)

1281 EPILATION INDUCED BY X RAYS IN GUINEA PIGS. A. Maggiora (Clinique Universitaire de Dermatologie, Geneva). Dermatologica, 123: 106-14(1961). (In French)

A 3-cm diameter area of guinea pig skin was irradiated with various doses to determine the min. dose inducing epilation. This dose was between 400 and 800 r since 400 r failed to induce it but 800 r consistently caused epilation. After 800 r the hair began to fall out between the 8th and 12th day and alopecia was macroscopically complete by the 11th to 15th day. The hair began to return during the 2nd month but even 3 to 4 months later regrowth of hair was incomplete and the irradiated zone was clearly distinguishable. Hair fell out more slowly after 1600 r than 800 r, and with the higher dose no regrowth of hair occurred during the 8-month observation period. Varying the quality of the x-rays, with the tube operated at 10 to 70 kv, had no effect on the onset or duration epilation. Fractional doses given 1 day apart were much less effective than single doses, for example, four 200-r doses or eight 200-r doses caused no epilation although the total doses given singly were effective. Arrest of mitosis was not related to epilation; higher doses of x rays were required to arrest mitosis in the hair bulb than in nipple epidermis or condylomata acuminatum (venereal warts). (H.H.D.)

1282 EPILATION INDUCED BY X RAYS IN THE GUINEA PIG (FRACTIONATED DOSES AT INTERVALS OF 6, 12, AND 24 HOURS). A. Maggiora (Clinique Universitaire de Dermatologie, Geneva). Dermatologica, 123: 115-18(1961). (In French)

A single dose of 800 r delivered to an area of guinea pig skin 3 cm in diameter regularly caused epilation. However, no epilation followed four 200-r doses given at intervals of 24 hr, or even after eight 200-r doses. In contrast, either of these fractional doses given at 12-hr intervals produced epilation. The same fractional doses at 6-hr intervals were also effective. A single 1600-r dose caused persistent alopecia compared with the transient (1- to 2-month) hair loss caused by 800 r. However, if the 1600-r dose was given fractionally the duration of alopecia was diminished. These results in guinea pigs differ from results on fractional doses necessary to induce erythema in man, which showed that the effect diminished as the interval was decreased below 24 hr. The threshold epilatory dose is higher in guinea pigs than man. (H.H.D.)

1283 EARLY REVERSIBLE EFFECTS OF IRRADIATION OF THE EMBRYONIC HEART. Georges Le Douarin (C.N.R.S., Saclay, France). Compt. Rend., 255: 587-9 (July 16, 1962). (In French)

The localized irradiation of the heart of the chicken embryo, exposed at the third day of incubation, causes modifications of the cardiac physiology, involving the pulsating force, which is reduced, and the rhythm, which is accelerated. These phenomena occur early and are generally reversible, even for high radiation doses. (tr-auth)

1284 RADIOCHEMICAL CHANGES IN GENES. A. Wacker (Universität, Frankfurt am Main). Deut. med. Wochschr., 86: 735-40(Apr. 14, 1961).

The effects of ultraviolet and ionizing radiation on nucleic acids and their constituents are reviewed. (H.H.D.)

1285 THE EFFECT OF HIGH, X-RAY DOSES ON THE GROWTH AND EXCHANGE OF PHYSIOLOGICALLY ACTIVE SUBSTANCES IN PEA SPROUTS. S. O. Grebinskii, L. P. Strugovshchikova, and E. I. Liteplo (Franko Government Univ., L'vov). Doklady Akad. Nauk SSSR, 146: 471-4(Sept. 11, 1962). (In Russian)

Seeds of the sugar pea were subjected to an x-ray dose of 10,000 r, and were placed in a water bath for 5 days at 24°C. The auxins were extracted with ether in the cold, and were separated by paper chromatography into various fractions. The biological activity of the growth stimulators in the neutral fraction fell off considerably. The content of heteroauxins in the acid fraction was also decreased. Pea cuttings from unirradiated shoots showed a weight increase of 58%, while the irradiated pea cuttings gave only a 4% increase in weight in comparison to the control. Various abnormalities were observed in the irradiated sprouts. The addition of biotin (0.1 to 0.5 μg/20 ml) and of gibberellic acid (10 μg administered daily for one week at the point of sprouting) stimulated the growth of the irradiated plant, particularly in the rootlet and in the side sprouts. Growth in the stem was observed only with the addition of biotin (0.5 μg/20 ml). Growth of the rootlet was stimulated more readily than growth in the stem. (TTT)

1286 RADIOSENSITIVITY OF CELLS OF CHINESE HAMSTER IN VITRO IN RELATION TO THE CELL CYCLE. T. C. Hsu, W. C. Dewey, and R. M. Humphrey (Univ. of Texas, Houston). Exptl. Cell Res., 27: 441-52(Sept. 1962).

Analyses of radiation damage to chromosomes were made with Chinese hamster cells grown in vitro. The cells were pulse-labelled with tritiated thymidine immediately before irradiation. Samples were taken every two hours postirradiation for either metaphase or anaphase study. It was found that the cells originally in the G_2 phase were about three to four times more radiosensitive than those in the S phase. It was also found that breakages of the chromosomal type induced by radiation only occurred among cells in the G_1 phase, and were absent among cells in the S phase at the time of irradiation. This suggests that the subunits of each chromatid separate at the time the cell commences DNA synthesis. (auth)

1287 DIFFERENT EFFECTS OF 5-FLUORODEOXYURIDINE AND 5-BROMODEOXYURIDINE ON THE FREQUENCIES OF CHROMATID ABERRATIONS OBTAINED IN VICIA FABA AFTER IRRADIATION WITH X-RAYS. B. A. Kihlman (Univ. of Uppsala). Exptl. Cell Res., 27: 604-7 (Sept. 1962).

Results of a study on the production of chromosomal aberrations in Vicia faba by 5-fluorodeoxyuridine (FUDR) and by 5-bromodeoxyuridine (BUDR) alone, and in combination with x radiation, indicate that the chromosomal damage obtained after x irradiation may be increased by both FUDR and by BUDR, but that the effects are qualitatively different and are probably produced by different mechanisms. (C.H.)

1288 EFFECTS OF PRENATAL X-RAY IRRADIATION ON AUDIOGENIC SEIZURES IN THE RAT. Jack Werboff, Joan Den Broeder, Joan Havlena, and Melvin R. Sikov (Wayne State Univ., Detroit). Exp. Neurol., 4: 189-96(Sept. 1961).

Gravid albino rats of the Sprague-Dawley strain received 25, 50, or 100 r whole-body x irradiation on days 5, 10, 15, or 20 of gestation. Controls were sham-irradiated. Over 500 surviving offspring were evaluated for susceptibility to audiogenic seizures under two conditions of threshold testing, with the bell alone and with a pretreatment of Metrazol (16 mg/kg). The tests were conducted when the animals were 120 and 122 days of age. Irradiation on days 5 or 10 of gestation resulted in a decrease in seizure responses, while irradiation on days 15 or 20 of gestation resulted in an increase in seizure responses. The differences were more pronounced under the lowered threshold condition. These findings appeared to be independent of dosage. It was concluded that low levels of prenatal irradiation can alter the threshold of susceptibility to audiogenic seizures in the offspring. (auth)

1289 EFFECT OF IONIZING RADIATION ON THE FREE DEOXYRIBONUCLEOSIDE AND DEOXYRIBONUCLEOTIDE CONTENT OF REGENERATING RAT LIVER. J. Soška, M. Skalka, and M. Bezděk (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Folia Biol. (Prague), 8: 239-50(1962). (In English)

The free deoxyriboside and deoxyribotide level in rat liver was studied during regeneration after partial hepatectomy, after irradiation, and after the injection of cortisone. Regeneration was characterized by a mild increase in the deoxycytidine concentration and a marked increase in the deoxycytidylic acid concentration and in particular in the thymidylic acid concentration. After irradiation the methyldeoxycytidine and thymidylic acid concentration was lowered in normal and regenerating liver, while the deoxycytidylic acid level was lowered in regenerating liver and the deoxyuridine level was somewhat lowered in normal liver. The concentration of some deoxyribosidic substances in the liver rose, however, after irradiation. The deoxycytidylic acid level rose in normal liver, but not in regenerating liver, the deoxyuridine and thymidine level rose in regenerating liver and the deoxyuridylic acid and deoxycytidine level rose both in normal and in regenerating liver. Some of the given criteria showed that cortisone had a similar effect to that of radiation, but of a lower degree, and in some cases no effect of cortisone was detected. (auth)

1290 THE EFFECT OF X-RAY IRRADIATION ON THE MITOTIC INDEX AND THE PROPORTION OF MITOTIC PHASES IN MOUSE BONE MARROW CULTIVATED IN VIVO IN A HOMOLOGOUS HOST. Blažena Koukalová (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Folia Biol. (Prague), 8: 251-5(1962). (In English)

The effect of x irradiation on the mitotic index and metaphase/prophase quotient in mouse bone marrow cultivated in vivo in a homologous host was studied. The mitotic index was lowered in bone marrow from donors irradiated with 200 and 50 r and the metaphase/prophase quotient was raised. Bone marrow from donors irradiated with a dose of 10 r did not differ significantly in respect of these indicators from bone marrow from non-irradiated donors. (auth)

1291 OXYGEN CONSUMPTION IN MICE IRRADIATED WITH X-RAYS AT DIFFERENT DOSE RATES. A. Vacek (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Folia Biol. (Prague), 8: 263-6(1962). (In English)

O_2 consumption in mice was studied during x irradiation at a rate of 50, 98, and 195 r/min. O_2 consumption in mice irradiated at a rate of 98 r/min increases, while in mice irradiated at a rate of 195 r/min it decreases. The increase in O_2 consumption occurs during the first minutes of irradiation, while the decrease is observed after a latent period of five minutes. O_2 consumption in animals irradiated at a rate of 195 r/min after chordotomy did not change. On the basis of the results the author shows that changes in O_2 consumption in mice and rats are correlated to the intensity of radiation and draws attention to the great significance of peripheral pathways in the direct changes in O_2 consumption which occur in animals in response to irradiation. (auth)

1292 THE RESULTS OF IRRADIATION THERAPY OF CARCINOMA OF THE CERVIX. E. L. Makowski, J. L. McKelvey, G. W. Flight, K. W. Stenstrom, and Donn G. Mosser (Univ. of Minnesota, Minneapolis). J. Am. Med. Assoc., 182: 637-42(Nov. 10, 1962).

The effectiveness of accurately applied irradiation therapy for carcinoma of the cervix was determined. In our study, 1178 patients with carcinoma of the cervix were given primary irradiation therapy. Nine patients had primary surgical therapy and 15 patients had no therapy. External irradiation was administered first. On the last day of external irradiation treatment, radium was inserted into the upper vagina, cervix, and uterus. The patients in the various stages were grouped as follows: 422 patients had Stage 1 lesions, 426 patients had Stage 2 lesions, 286 patients had Stage 3 lesions, and 59 patients had Stage 4 lesions. The absolute 5-year-survival rates were 81% for Stage 1, 60% for Stage 2, 35% for Stage 3, and 3% for Stage 4. The overall 5-year survival rate was 58.8%. (auth)

1293 EFFECT OF X IRRADIATION ON Na AND K SECRETION BY HUMAN PAROTID GLAND. H. K. Awwad and Y. A. Habib (Alexandria Univ., Egypt). J. Appl. Physiol., 17: 677-82(July 1962).

Twelve patients were studied; all were suffering from various malignant tumors where radiation therapy was indicated and involved irradiation of one or both parotid glands. Secretion of Na and K was determined in parotid saliva over secretory rates ranging from 0.06 to 2.2 ml/min. Na concentration in saliva was linearly related to flow rate, whereas K concentration was negatively correlated to salivary secretory rate. X irradiation by itself did not influence the secretion of Na apart from its influence on flow rate, but with K a greater regression coefficient of K secretion per min and flow rate was noted. This was associated with a significantly higher K/Na ratio in the saliva. This effect seemed to be a local one, since in some patients where only one parotid gland was irradiated, these changes were noted only in the irradiated gland. It is unlikely, therefore, that the observed lowering of the Na/K ratio was the result of any adrenocortical overactivity produced by the stress of irradiation. It is suggested that radiation cellular damage might render intracellular K more available for salivary secretion. (H.H.D.)

1294 "MUTATIONAL SYNERGISM" OF ULTRAVIOLET LIGHT AND CAFFEINE IN ESCHERICHIA COLI. Delbert M. Shankel (Univ. of Kansas, Lawrence). J. Bacteriol., 84: 410-15(Sept. 1962).

When ultraviolet-induced mutations of Escherichia coli B/r develop in the presence of caffeine, there is a large increase in mutant numbers. The development of these extra mutants is not affected by the presence of normally occurring purines and pyrimidines, azauracil, azathymine, or 5-methyltryptophan, but many of the mutants can be photoreversed. They are stabilized or lost during the first hour of postirradiation growth. Enzymatically active materials

extracted from E. coli cells do not interfere with the caffeine effect, and variation of the growth temperature during the development of the mutations fails to alter the effect. Prefeeding the cells with caffeine prior to irradiation does not produce the response. The effect is observable with both stationary-phase and log-phase populations, but is not observable when a relatively high dosage of ultraviolet light is employed. (auth)

1295 DELAYED EFFECTS OF MULTIPLE SUBLETHAL DOSES OF TOTAL BODY X IRRADIATION ON THE PERIODONTIUM AND TEETH OF MICE. Richard C. Greulich and Benjamin H. Ershoff (Univ. of California, Los Angeles). J. Dental Res., 40: 1211-24(Nov.-Dec. 1961).

Effects of multiple sublethal doses (6 weekly exposures of 200 r each) on the subsequent appearance of the periodontal and dental tissues were studied in male mice fed either a highly purified diet complete in all know nutrients or a natural food stock ration. Periodontal lesions were observed in x-irradiated animals on the purified diet 100 days following the 1st irradiation exposure, but not prior to this time. The subsequent development of the lesions generally paralleled that of primate periodontitis and was characterized by plaque formation, gingival recession, periodontal destruction, dental necrosis, and exfoliation. In contrast, no periodontal pathology was observed in x-irradiated mice on the stock diet. Multiple sublethal x irradiation appears to be a primary etiologic factor in the formation of periodontal lesions in mice fed the purified diet. Secondary factors, such as age, diet, trauma, oral bacterial flora, heredity, may also be implicated. Two manifestations of radiation injury, namely, diminution of body resistance to infection and the so-called aging effect of radiation, should be considered too. Histologic studies indicated that salivary function, particularly of the palatal gland system, was impaired. Areas of fibrosis and reduced glandular tissue were prominent in several irradiated animals on the purified diet. This suggests a more specific type of radiation-induced somatic lesion, with its focus upon the oral environment. Impaired salivary function could play an important etiological role in the lesions observed, by facilitating the accumulation of plaque material. (H.H.D.)

1296 CERTAIN BIOLOGICAL EFFECTS PRODUCED IN THE BOLL WEEVIL BY TAGGING IT WITH P^{32}. M. S. Mayer and J. R. Brazzel (Texas Agricultural Experiment Station, College Station). J. Econ. Entomol., 54: 1197-1203 (Dec. 1961).

The weevils (Anthonomus grandis) were labeled with P^{32} by feeding water containing $H_3P^{32}O_4$ to the adults or feeding the larvae diets containing $H_3P^{32}O_4$. Weevils became highly radioactive if allowed to feed on a solution containing 225 μc/ml of P^{32}. An average activity of 64,856 cpm during the first 24 hr was recorded. Weevils removed from the radioactive food after the second day of feeding and placed on nonradioactive cotton squares lost 57% of the radioactivity during the first 24 hr. After 16 days they had lost 97% of the initial activity, however, they still exhibited an average of 4,179 cpm. Weevils reared in diet containing 1.65 μc/g lost 90% of the radioactivity between the 15th and 20th days. Weevils reared in 9.91 μc/g of diet lost 90% of the radioactivity after 25 days. Studies of the effects of P^{32} on fecundity, longevity, lengths of oviposition, and preoviposition periods disclosed that the weevils reared from radioactive larval diet were more adversely affected than the weevils fed as adults. Females reared from the 2 highest dosages (4.9 and 9.9 μc/g) in the diet failed to lay eggs. Larval mortality increased in proportion to the amount of radioactivity in the diet, and mortality was always greater and began sooner for the weevils reared in radioactive larval diet. All males alive after 40 days from the 2 highest doses were fertile. The radioactivity of eggs laid by female adults fed P^{32} in solution ranged from 0 to 50 cpm per egg. There was no evidence of adverse effects on viability in these eggs with about 90% hatching. F_1 individuals from these eggs showed no observed radioactivity and no apparent adverse effects on longevity and fecundity. Feeding adults P^{32} in solution appears to be the better method of labeling boll weevils for field experimentation. (H.H.D.)

1297 THE ONSET OF PUBERTY AFTER X IRRADIATION. Heather M. Beaumont (Univ. of Birmingham, Eng.). J. Endocrinol., 24: 113-14(Mar. 1962).

The effect of irradiation of the ovaries of rats on ovarian function was investigated. Previous reports have indicated that follicular development and onset of puberty are accelerated by irradiation, and these findings have given impetus to the questionable practice of ovarian irradiation in human cases of sterility. Rats were exposed to 645 r on both the 7th and 14th days after birth. Other animals served as unirradiated controls; some of these received anesthetic (tribromoethanol), but during exposure the anesthetized animals were almost completely shielded with lead. The results demonstrate that the onset of puberty is not accelerated following ovarian irradiation during the first 2 weeks after birth and that secretory capacity of the ovaries is decreased following irradiation. While the vaginal estrous changes were comparable in the 2 groups of animals, the weight of the uterus was lower in the irradiated than in the control rats. The reduction in secretory function appeared to be correlated with ovarian atrophy. Although a few oocytes at the later stages of follicular growth were identified in most of the irradiated ovaries, the latter also contained numerous cystic and degenerating follicles and cystic corpora lutea. These degenerative changes were reflected by a reduction in ovarian weight. The conclusion that ovarian irradiation is followed by a diminution in the output of estrogen is supported by the previous observation that experimental animals showed slight hypertrophy of the pituitary gland and slight involution of the adrenal gland. The present results thus fail to confirm the hypothesis that x irradiation stimulates ovarian function by causing excessive follicular growth. The fact that precocious vaginal opening was not observed in the 2 animals in which only the anterior half of the body was shielded during exposure to x rays suggests that the direct effects of irradiation are insufficient per se to induce early breakdown of the vaginal closure membrane. Previous experiments failed to subject control animals to the same degree of nonspecific stress (i.e. anesthesia) as experimental animals. Thus the possibility that the induction of precocious puberty was entirely of a nonspecific nature cannot be eliminated. (H.H.D.)

1298 STUDIES ON THE MICROFLORA OF SOIL UNDER CHRONIC IRRADIATION. J. P. Skou (Danish Atomic Energy Commission Research Establishment, Riso, Denmark). J. Gen. Microbiol., 28: 521-30(July 1962).

The effects of a Co^{60} source on the microflora in subjacent soils, as expressed by oxygen uptake of soil samples and by counts of bacteria and fungi, were studied. The number of micro-organisms present in soil located at a distance of 4 cm from the source (76 rad/hr 1 m above ground) declined considerably after 24 hr of exposure. Respirometric determinations showed no decrease in oxygen uptake at this time. The distance at which the effect of irradiation could be demonstrated increased with increasing duration of exposure; after 396 days a reduction of the oxygen uptake as well as of the number of microbes could be detected at a

distance of more than 3 m and at a depth of 10 cm as well as at the surface. No significant difference between the effects of chronic irradiation on spore-forming and on non-spore-forming bacteria was noted. The plot of microbial count showed a better fit to a double-logarithmic than to a semi-logarithmic diagram according to Lea's formula. The conclusion is drawn that the same laws apply to irradiation of natural populations and to irradiation of pure cultures, only the results are depicted differently, because in the case of the natural populations the curve is a sumcurve. (H.H.D.)

1299 PHOTOENZYMATIC REPAIR OF ULTRAVIOLET DAMAGE IN DNA. I. KINETICS OF THE REACTION. Claud S. Rupert (Johns Hopkins Univ., Baltimore). J. Gen. Physiol., 45: 703-24(Mar. 1962). (TID-13593)

Kinetics of the photoenzymatic repair of UV damage in DNA in the presence and absence of inhibitors, were found consistent with the Michaelis-Menten reaction scheme, with the sites of ultraviolet damage on the DNA serving as substrate and the repaired structure as product. Kinetic studies with different light intensities suggested that the necessary illumination caused photolysis of the enzyme-substrate complex with concurrent repair of the DNA. Competitive inhibition of irradiated transforming DNA repair, which occurred when irradiated non-transforming DNA was present in the same reaction mixture, permits ultraviolet damage (of the kind capable of being photoreactivated) to be detected in any type of DNA. (auth)

1300 PHOTOENZYMATIC REPAIR OF ULTRAVIOLET DAMAGE IN DNA. II. FORMATION OF AN ENZYME-SUBSTRATE COMPLEX. Claud S. Rupert (Johns Hopkins Univ., Baltimore). J. Gen. Physiol., 45: 725-41(Mar. 1962). (TID-13594)

Gentle fractionation precedures capable of separating unbound enzyme from DNA, as well as by the altered properties of the enzyme when combined with its substrate, were used to show that the enzyme-substrate complex is a stable compound in the dark. It was found that the photoreactivating agent from bakers' yeast is bound to UV irradiated DNA in the dark (but not to unirradiated DNA), and that in this form it is partly protected from inactivation by heat and heavy metals. The results support the indications from kinetic evidence that photoreactivation proceeds by the Michaelis-Menten reaction scheme, with the enzyme first attaching to the photochemical lesion of DNA in the dark, and the repair occurring during subsequent first order photolysis of the enzyme-substrate complex. (P.C.H.)

1301 ESTRADIOL TREATMENT AND THE X-RAY-INDUCED ACCELERATION OF THE AGE-SPECIFIC MORTALITY RATE. Henry I. Kohn, Aldo N. Corbascio, and Paul H. Guttman (Univ. of California, San Francisco). J. Natl. Cancer Inst., 29: 853-62(Nov. 1962).

BALB/c female mice, 430 days old, were irradiated with 250 kvcp x rays (in single or split doses) and were followed for 40 weeks. The irradiation increased the age-specific mortality rate, m_x, but only after a 16-week (403 rads) or an 8-week (831 rads) period. Intramuscular injection (5 μg every 4 weeks) of long-acting estrogen (estradiol-17β-n-valerianate, Delestrogen) practically abolished the latent periods and tended to increase m_x throughout the experiment. Estrogen treatment, as reflected in the cumulative percent survival curve, had less effect in the nonirradiated mouse than in the irradiated one. It had more effect on the 403 rad group than on the 831 rad group, and thus brought their survival curves close together. From a study of tumor incidence in decedents and animals that were killed, it was concluded that the effect of estrogen on mortality was not the result of tumor induction, though during the first half of the experiment estrogen tended to hasten the death of irradiated animals with pulmonary tumors. (auth)

1302 THE NITRITE SENSITIVITY OF ERYTHROCYTES FOLLOWING GAMMA RADIATION: THE EFFECT OF VERY LOW DOSES. W. K. Metcalf (Univ. of Bristol, Eng.). J. Physiol. (London), 163: 17P-18P(Aug. 1962).

The resistance of intracellular hemoglobin to oxidation by nitrite ions is decreased in the rat by whole-body radiation in the range 3 to 1000 r. In an attempt to find the minimum effective dose for rats, the dose level was diminished to the maximum permissible exposure range for man. Worcester substrain Lister hooded rats were irradiated in a Perspex cage. To prevent too great a change in the radiation time it was necessary to change the dose rate from 1250 r/hr used originally to 250 r/hr for the 4, 2, and 1 r experiments. The very small doses ($\frac{1}{3}$ to $\frac{1}{30}$ r) were obtained from suitably placed Co^{60} needles (5 × 15 mc) giving 0.5 r/hr. The major difference between the effects of the varying levels of irradiation is the increasingly delayed onset of the change in nitrate sensitivity of the hemoglobin as the dose diminishes. With the exception of the smallest dose given ($\frac{1}{30}$ r), the final level of sensitivity of hemoglobin to oxidation is virtually independent of the dose. Some rats were irradiated (4 r) with 11.7 cm of lead shielding abdomen, hind limbs, and tail. The onset of the increased hemoglobin sensitivity was unaffected by this screening, but the maximum effect was delayed so as to coincide in time with that of much smaller doses. (H.H.D.)

1303 EFFECTS OF POST TEMPERATURE TREATMENTS ON THE X-RAY INDUCED CHROMOSOME ABERRATIONS IN THE PMCs OF TRILLIUM (PRELIMINARY REPORT). Hajime Matsuura, Shigeyuki Tanifuji, and Masaki Iwabuchi (Hokkaido Univ., Sapporo). Japan J. Genetics, 36: 419-22(Dec. 1961). (In English)

The effects of post-irradiation temperature treatments upon the x-ray-induced chromosome aberrations were studied with the pollen mother cells of Trillium kamtschaticum Pall. Post low temperature treatment for the period of about 76 hr caused the delay of the progress of cell division. The frequencies of the chromosome aberrations, especially the frequency of chromatid translocations, were lower in the material posttreated with low temperature in comparison with the case of higher temperature. (auth)

1304 RADIOBIOLOGICAL STUDIES IN PLANTS. V. EFFECTS OF X- AND GAMMA-IRRADIATIONS ON POLLEN FERTILITY OF LYCOPERSICUM PIMPINELLIFOLIUM. Ichizo Nishiyama and Setsuko Tsukuda (Kyoto Univ.). Japan J. Genetics, 36: 423-7(Dec. 1961). (In English)

Ripe pollen grains of Lycopersicum pimpinellifolium were exposed to 230 kvp x rays, and 1.17 and 1.33 Mev mixed gamma-rays from ~Co^{60} source, ranging from 10 kr to 110 kr at increments of 10 kr. According to the authors' previous study pollen grains irradiated with these dosages of x-rays germinated very well in vitro. In the present investigation, 1,207 and 203 flowers which were previously emasculated were pollinated with irradiated and nonirradiated pollen grains, respectively. The percentage of fruit-setting and the weight of fruits distinctly decreased when pollen grains were exposed to increasing doses of radiation. These fruits set few plump and viable seeds, but some small and empty seeds were obtained in numbers clearly inversely proportional to the amount of irradiation doses. Only six plump seeds were obtained in 537 fruits fertilized with irradiated pollen grains and five of them germinated.

All of them had the normal number of chromosomes (2n = 24) of L. pimpinellifolium. No difference on biological effects between x and gamma-irradiation was recognized in the present experiment. (auth)

1305 SENSITIVITY OF RATS TO X RADIATION AT BODY TEMPERATURE LOWER THAN 10°C. Riccardo Benvenuto (Northwestern Univ. Medical School, Chicago). Minerva Nucl., 6: 178-80(June 1962). (In Italian)

The protective effect of profound hypothermia against the deleterious action of x radiation was studied in rats. A single dose of 800 r and 1500 r respectively was administered to rats while in deep hypothermia to the point of cardiorespiratory arrest. Each group had a control series of animals simultaneously exposed to the same amount of radiation at normal body temperature. A mortality rate of 100% in 4 weeks was observed in the controls. Among the rats irradiated in hypothermia a survival rate of 83.3% for the animals receiving 800 r and a survival rate of 60% for those receiving 1500 r was obtained. (auth)

1306 THE EFFECT OF IONIZING RADIATION ON NUCLEIC ACIDS. (A COMPARATIVE STUDY). S. Zadražil (Inst. of Organic Chemistry and Biochemistry, Czechoslovak Academy of Sciences, Prague). Neoplasma, 9: 395-410(1962). (In English)

On the basis of a review of present knowledge on the effect of ionizing radiation on nucleic acids, the author evaluates the changes observed in his experiments in various fractions of RNA from the livers of rats irradiated in vivo with x rays. The possible mechanisms involved in the decrease of RNA content in the tissue following irradiation and the possible consequences of the structural changes of RNA for its biological role are discussed. (auth)

1307 DECREASE IN VAGINAL CAPACITY WITH RADIATION THERAPY. Robert M. Ruch, H. M. Vaugh, Edward L. Taylor, and David S. Carroll (Univ. of Tennessee, Coll. of Medicine, Memphis). Obstet. Gynecol., 19: 499-504(Apr. 1962).

All 31 patients treated for carcinoma of the cervix with radiation therapy showed postradiation shrinkage of the vagina, even when adhesive mucositis was kept to a min. Eight of 18 patients receiving external roentgen therapy prior to radium showed an average vaginal shrinkage following the 1st therapy of 14% of the circumference of the upper vagina and 31% of the total vaginal capacity. In these 8, plus 5 of 26 others, there was enough limitation of the vaginal vault to require a change from the usual radium application. Maximum shrinkage was reached by 5 months. (H.H.D.)

1308 THE EFFECT OF TOTAL-BODY IRRADIATION ON THE ORAL TISSUES OF THE SYRIAN HAMSTER. J. Mayo, F. A. Carranza, Jr., C. E. Epper, and R. L. Cabrini (Comisíon Nacional de Energía Atomica, Buenos Aires). Oral. Surg., Oral Med., Oral Pathol., 15: 739-45(June 1962).

Whole-body doses of 400 to 2000 r were given to 6- to 8-week-old hamsters (Mesocricetus auratus) to study the gross and histologic lesions developing in the oral region. Hamsters irradiated with doses of 700 r or more underwent a rapid systemic deterioration, with severe diarrhea, dehydration, and loss of weight. Edema of the face and fauces and suppurating blepharitis, progressing in a few cases to large orbital abscesses, were frequently found, especially with the higher doses. A hemorrhagic exudation was frequently seen coming from the nasal fossae. Animals irradiated with 400 r did not show oral lesions. With 500 r and 600 r, occasional small, noncharacteristic lesions in the oral cavity, such as excoriations and wounds, were noted. With 700 r, oral lesions were found in 30% of the animals; with 900 r and higher doses, oral lesions appeared in all animals. Oral lesions consisted of yellowish gray areas, apparently necrotic, in the following localizations: (1) gingival tissue in the lingual aspect of the lower incisors, (2) palatal aspect of the upper incisors, and (3) palatal gingival of the upper molars. With higher doses, the lesions were of greater severity and appeared in other areas of the oral cavity, especially the tongue. In the animals that survived the 30-day experimental period, the oral lesions healed, leaving such sequelae as marked gingival recessions and retractile scars with obliteration of the mucobuccal fold. Microscopic lesions in the upper molar area were characterized by a sudden interruption of the normal oral mucous membrane, close to the periodontal region and its replacement by a necrotic area of variable size. Neither these necrotic areas nor the surrounding mucous membrane had any hemorrhagic foci. The pulp was vital in spite of the presence of large areas of necrosis in the neighboring alveolar bone. The irradiated animals fed hard and soft diets showed only slight differences. The number of lesions found in the latter group was slightly greater than that found in the former group, although they were more severe than those found in the hard-diet group. (H.H.D.)

1309 ON ESTIMATING THE CONSTANTS OF THE 'MULTI-HIT' CURVE USING A MEDIUM SPEED DIGITAL COMPUTER. Sylvanus A. Tyler and Merlin H. Dipert (Argonne National Lab., Ill.). Phys. Med. Biol., 7: 201-12(Oct. 1962). (TID-16646)

A 1-pass computer program in FORTRAN is presented that produces least squares estimates and standard errors for the constants of the Multi-Hit curve. The mathematical expression for the curve is $S = 1 - [1 - \exp(-kD)]^n$ where S is the proportional response to a dose D, and k and n are constants to be estimated. The program permits the choice of 3 weighting factors and accepts data entered as individual values or as means with associated weights. (auth)

1310 REMOTELY-CONTROLLED AFTERLOADING RADIOTHERAPY APPARATUS. (A PRELIMINARY REPORT). Rune Walstam (Inst. of Radiophysics, Stockholm). Phys. Med. Biol., 7: 225-8(Oct. 1962).

An apparatus is described that makes it possible by remote control to insert radioactive sources into empty tubes which had previously been positioned in a patient. Its purpose is to reduce radiation exposure of staff during application and removal of the source as well as during the treatment time. Its use is mainly envisaged for gynecological tumors. (auth)

1311 ON THE USE OF ROENTGEN-CALIBRATED, CAVITY-IONIZATION CHAMBERS IN TISSUE-LIKE PHANTOMS TO DETERMINE ABSORBED DOSE. G. P. Barnard, E. J. Axton, and A. R. S. Marsh (National Physical Lab., Teddington, Middx., Eng.). Phys. Med. Biol., 7: 229-40(Oct. 1962).

Roentgen-calibrated cavity-ionization chambers are frequently used to determine absorbed dose at a point in a tissue-like phantom. An N.P.L. calibration factor for 2Mv x rays, assigned to a chamber and its associated measuring equipment, includes corrections for wall attenuation of the chamber, for any lack of electronic equilibrium, and for the stopping power of the wall material relative to air. When the chamber readings are used to calculate absorbed dose at a point in, say, a water phantom, a further correction is required to determine the exposure dose that would have been obtained at the point in the absence of the chamber and any wall-thickening cap used in the calibration. Some recent work dealing with the

determination of this correction has been critically examined. It is shown that the correction factor required to compensate for the attenuation of the phantom material removed to accommodate the chamber and its cap can be determined from experimental data already available. A rad/roentgen conversion factor for 2 Mv x rays and a water phantom is calculated. (auth)

1312 EXPOSURE DOSE MEASUREMENTS. T. E. Burlin (Hammersmith Hospital, London). Phys. Med. Biol., 7: 241-2(Oct. 1962).

The calibration of ionization chambers for use in exposure dose measurements in megavoltage x-ray therapy is discussed. The attenuation of scattered photons and secondary electrons by the chamber wall is considered. (C.H.)

1313 THE INFLUENCE OF PRE-IRRADIATION TREATMENT ON THE CHEMICAL EFFECTS OF THE $Cl^{35}(n,p)S^{35}$ REACTION IN ALKALI CHLORIDE CRYSTALS. A. G. Maddock and R. M. Pearson (Cambridge Univ., Eng.). Proc. Chem. Soc., 275-6(Aug. 1962).

Defects introduced into the alkali chloride lattice by any of 3 well-established techniques lead to a high S^{35--}: $S^{35}O_4^{--}$ ratio and the S^{35--} in these crystals undergoes aerial oxidation to sulfate far less readily during neutron irradiation. Introduction of 10^{-4} to 10^{-5} mole fraction of $CaCl_2$ or $CdCl_2$ into KCl crystals increased the S^{35--} content to as much as 57% after irradiation of the crystals in air. A control sample of pure KCl gave <1% of S^{35--}. Such doped crystals contain cation vacancies. Pre-irradiation of NaCl crystals with ionizing radiation is known to create F and V centers and their derivatives. It was found that preneutron irradiation with doses of 2-Mev electrons of 10, 20, and 100 Mrad led to 58.2, 77.0, and 88.1%, respectively, of S^{35--}. These results were obtained with crystals irradiated with neutrons in air. Na-enriched crystals were prepared by heating single crystals grown from melts in Na vapor. The product was blue, indicating that colloidal Na was already present. The percentage of S^{35--} was very high, even after neutron irradiation in air: a dark blue crystal contained 94.6% and a medium blue crystal contained 90.1% S^{35--}. Storage of the neutron-irradiation Cd-doped crystals for 2 weeks in air gave no measurable change in S^{35--} content, but crushing these crystals in air reduced the percentage of S^{35--} from 34% to 22%. Thus the behavior of S^{35} is profoundly affected by the defect density, and possibly by the nature of the defects, in the crystals that are irradiated. (H.H.D.)

1314 AN AUGMENTING EFFECT OF DOSE FRACTIONATION ON RADIATION-INDUCED MUTATION RATE IN MICE. W. L. Russell (Oak Ridge National Lab., Tenn.). Proc. Natl. Acad. Sci. U. S., 48: 1724-7(Oct. 1962).

The induced mutation rate obtained from spermatogonia of mice exposed to a dose of 1,000 r of 90 r/min x rays delivered in two fractions of 500 r separated by 24 hr is more than five times the rate observed for a single 1,000 r dose. (auth)

1315 DYE-SENSITIZED PHOTOINACTIVATION OF YEAST IN RELATION TO THE X-RAY OXYGEN EFFECT. R. B. Uretz and R. H. Haynes (Univ. of Chicago). Proc. Natl. Acad. Sci. U. S., 48: 1738-45(Oct. 1962).

Under anaerobic conditions, x rays inflict latent, nonlethal lesions which enhance the sensitivity of surviving cells of yeast to subsequent inactivation by visible light in the presence of the nucleic acid fluorochrome, acridine orange. No such enhanced sensitization occurs if the x rays are delivered under aerobic conditions, or if the order of the radiations is reversed, or when ultraviolet light is substituted for the dye visible light treatment. Thus, conditions which appear to protect cells from the effects of x rays (e.g., anoxia), may, at the same time, serve to promote the formation of x-ray-induced lesions that sensitize them in other ways. (auth)

1316 EFFECTS OF RADIOPROTECTIVE AGENTS ON FOOT DEFORMITIES AND GAIT DEFECTS IN THE PRENATALLY X-IRRADIATED RAT. Benjamin H. Ershoff, Cecil W. Steers, Jr., and Lawrence Kruger (Western Biological Labs., Culver City, Calif. and Univ. of California, Los Angeles). Proc. Soc. Exptl. Biol. Med., 111: 391-4 (Nov. 1962).

The radioprotective agents AET, cysteamine, and MEG largely prevented the occurrence of foot deformities and a defect in gait in the young of rats exposed to a single dose of 150 r total-body x irradiation on the 14th day of pregnancy. These substances also prevented in part the occurrence of an abnormality in development of the cerebral hemispheres of such young but were without significant effect in altering an attendant reduction in the ratio of brain to body weight. (auth)

1317 ACID DEOXYRIBONUCLEASE AND ACID PHOSPHATASE ACTIVITIES IN REGENERATING RAT LIVER AFTER WHOLE-BODY X-IRRADIATION. M. Goutier-Pirotte and R. Goutier (Centre d'Etude de l'Energie Nucleaire, Mol. Belg.). Radiation Res., 16: 728-35(1962). (BLG-128)

Acid DNAase and acid phosphatase activity were determined in regenerating livers of normal and irradiated rats. In normal rats, hepatectomy brings about an increase of acid DNAase between 12 and 18 hours postoperation. The possible role of this increase in the mitotic cycle is discussed. Fifteen per cent of acid DNAase and acid phosphatase activity is present in supernatant fraction of homogenates of normal and regenerating livers. This percentage is not changed in nonregenerating livers by irradiation by 700 r. In regenerating livers, however, irradiation with 700 r increases the percentage of free enzyme activity (from 15 to 30%) when it is given 10 minutes or 12 hours after hepatectomy. Irradiation 24 hours after hepatectomy no longer solubilizes the enzyme activities. (auth)

1318 THE EFFECT OF TOTAL-BODY X-IRRADIATION ON SERUM PROTEINS IN THE HAMSTER. Joern Ditzel (Boston Univ.; New England Deaconess Hospital, Boston; and Harvard Medical School, Boston). Radiation Res., 17: 694-702(Nov. 1962).

Golden hamsters were given a single dose of either 1500 or 1000 r of whole-body x irradiation. Paper electrophoretic fractionation of the serum proteins and microscopic observations of the microcirculation in the cheek pouch were made prior to and after irradiation. After 1500 r as well as after 1000 r of whole-body x irradiation the albumin fraction decreased, and the α_1-, α_2-, and β globulin fractions increased. A correlation was found between the degree of intravascular erythrocyte aggregation observed in the microcirculation of the cheek pouch and the decrease in the albumin/globulin ratio. This supports the concept that the phenomenon of sludging in vivo is governed by the same forces as those governing rouleaux formation in vitro. (auth)

1319 RADIATION DAMAGE AND FREE RADICAL PRODUCTION IN IRRADIATED RIBONUCLEASE. J. W. Hunt, J. E. Till, and J. F. Williams (Univ. of Toronto and Ontario Cancer Inst., Toronto). Radiation Res., 17: 703-11(Nov. 1962).

The effect of gaseous environment on the radiosensitivity of dry ribonuclease was examined. An oxygen effect was observed, similar in magnitude to that reported by others,

for enzymes irradiated in the dry state. Exposure of the enzyme to oxygen after irradiation under anoxic conditions yielded a reduction in enzymatic activity. Nitric oxide present during irradiation under anoxic conditions had a protective effect. Changes in the ESR spectrum were observed in every treatment which resulted in a change in the sensitivity of enzymatic activity, suggesting that a correlation exists between the stable free radicals produced in the irradiated enzyme and the effect of radiation on the activity of the enzyme. (auth)

1320 VISUAL ACUITY PERFORMANCE OF NORMAL AND FOCAL-EYE-IRRADIATED MONKEYS. W. Lynn Brown, Richard M. Ritter, and Arnold A. McDowell (Univ. of Texas, Austin). Radiation Res., 17: 712-17(Nov. 1962).

Twenty young adult monkeys were first trained to discriminate a white card with a centered black dot measuring 2 inches in diameter from a blank white card. The subjects were then sorted into four matched groups and given ocular exposure to protein radiation. The ocular doses received by the subjects of the four groups were 0, 500, 1000, and 2000 rads. After exposure, each subject was tested for 40 days on the discrimination of cards holding centered black dots with diameters of $1/4$, $1/8$, $1/16$, $1/32$, and $1/64$ inch from the blank white card. Statistical analysis of the results warranted the conclusion that the ocular exposure to proton radiation of the subjects of the 2000-rad group adversely affected their ability to discriminate a card holding a centered black dot with a $1/64$-inch diameter from a blank white card. Concurrent ophthalmological examination suggested that this deficit in visual acuity was due to severe keratitis. (auth)

1321 MODIFICATIONS IN ROOTS OF ZEA MAYS SEEDLINGS INDUCED BY X-IRRADIATION OF DRY SEED. Joe H. Cherry (Univ. of Illinois, Urbana). Radiation Res., 17: 718-23(Nov. 1962).

Exposure of dry Zea mays seeds to x rays produced modifications in the roots of growing seedlings examined at three days of growth. X irradiation of seed inhibited cell division in the root tips of growing seedlings but apparently had no effect on cell expansion. Therefore, seedling growth from x irradiated seed is due primarily to expansion of cells pre-existing in the embryo. Roots grown from x-irradiated seed were thicker and had more cells per cross section than roots from unirradiated seed. On the average, x irradiation had little effect on the cell cross section. Roots grown from x-irradiated seed had fewer cells in the root apex, whereas the cell length was doubled. (auth)

1322 EFFECT OF X-IRRADIATION ON NUCLEIC ACIDS IN ZEA MAYS. I. NUCLEIC ACID DISTRIBUTION AND METABOLISM IN THE SUBCELLULAR COMPONENTS OF CORN SEEDLINGS GROWN FROM NORMAL AND X-IRRADIATED SEEDS. Joe H. Cherry, R. H. Hageman, and J. B. Hanson (Univ. of Illinois, Urbana). Radiation Res., 17: 724-39(Nov. 1962).

X irradiation of dry Zea mays seeds decreased the content of microsomal RNA in the meristematic region of seedlings germinated from them. Meristematic cells from unirradiated seeds were characterized by a high level of microsomal RNA, whereas in maturing cells the majority of the RNA was associated with the mitochondria. Differential ultracentifugation and RNA analysis showed that exposure of seed to x rays apparently prevented the synthesis of new microsomes as ordinarily occurs with cell division but, not disrupt the metabolism of microsomes during expansion of cells in the root tip. This results in an increase in mitochondrial RNA. The RNA of the different subcellular fractions appear to have dissimilar nucleotide compositions. Microsomal RNA contains a higher amount of guanosine monophosphate (GMP) than the RNA of the other fractions, whereas the soluble RNA contains less GMP and more uridine monophosphate (UMP). X irradiation of dry Zea mays seeds enhanced the incorporation of precursors into the nucleic acids of all subcellular components of growing roots. Results show that the nuclei incorporated more precursors in vivo than the other cellular components. Generally, there was a greater incorporation of precursors into the RNA of the heavy mitochondria than into the light mitochondrial or soluble RNA fractions. The least amount of incorporation was into microsomal RNA. The incorporation of P^{32} into the RNA of the cytoplasmic components of intact roots was greater in the basal portion of the root (maturing cells) than in the meristematic zone. X irradiation inhibited the incorporation of amino acids into the protein of nuclei in vivo, but the incorporation was accelerated in vitro. (auth)

1323 EFFECT OF X-IRRADIATION ON NUCLEIC ACIDS IN ZEA MAYS. II. ON THE LEVEL OF RIBONUCLEASE ACTIVITY IN GROWING SEEDLINGS. Joe H. Cherry, R. H. Hageman, and J. B. Hanson (Univ. of Illinois, Urbana). Radiation Res., 17: 740-51(Nov. 1962).

X irradiation of dry Zea mays seeds greatly enhanced the activity of RNase in growing seedlings, especially in the meristematic tissue (root tip and mesocotyl). Meristematic cells normally have a low level of RNase activity, but the activity increases with cell growth and maturation. The RNase activity of root tips grown from x-irradiated seeds was enhanced as much as fivefold. The distribution of RNase among the subcellular components of root tissue was not affected by x irradiation. X irradiation reduced the RNase activity in the scutellum, a storage tissue, which was consistent with the reduced utilization of scutellar RNA. Studies on the incorporation of P^{32} into the nucleotides by in vitro degradation of endogenous root tip RNA showed that incorporation was primarily into the pyrimidine nucleoside di- and triphosphates. EDTA stimulated RNase activity in root tip and mesocotyl homogenates but had little effect on scutellum homogenates. (auth)

1324 IN VIVO AND IN VITRO RECOVERY OF IRRADIATED GAMETES OF ARBACIA PUNCTULATA. Patricia McClement Failla (Argonne National Lab., Ill.). Radiation Res., 17: 767-73(Nov. 1962).

The recovery from radioinduced cleavage delay in Arbacia eggs left inside the irradiated urchin for various lengths of time after irradiation (in vivo recovery) was investigated. The rate of recovery was less by a factor of nearly 100 than when irradiated eggs were left in sea water for a time before fertilization (in vitro recovery). The irradiation of eggs and sperm in vivo caused a cleavage delay about 20% less than that induced in the same gametes irradiated in vitro. A decrease in effect of about the same magnitude was observed when the eggs and sperm were irradiated in vitro in the absence of oxygen. That the lower in vivo recovery rate is not caused by a lower oxygen tension in vivo, however, was indicated by the complete independence of the in vitro recovery rate on the presence of oxygen. It was also found that the eggs were no longer capable of recovering rapidly in vitro after they had remained inside the irradiated animal for 4 or more hours. (auth)

1325 HEAVY ION IRRADIATION OF HeLa CELLS. R. A. Deering and Robert Rice, Jr. (Yale Univ., New Haven). Radiation Res., 17: 774-86(Nov. 1962).

HeLa cells were irradiated with 250-kvp x rays, 40-Mev α particles (+2), 69-Mev lithium ions (+3), 105-Mev carbon

ions (+6), and 130-Mev oxygen ions (+8). The x rays, α particles, and lithium ions gave multitarget-type survival curves showing thresholds at low dose. The carbon and oxygen ion irradiations gave exponential (single-hit) curves with no thresholds. (auth)

1326 THE EFFECT OF CONTINUOUS GAMMA IRRADIATION ON BAR PRESSING IN OLD RATS. Thomas M. Graham, Dunham H. Gilbert, Norman Gold, and Lawrence C. Callahan (Western Biological Labs., Culver City, Calif. and Los Angeles State College). Radiation Res., 17: 787-91 (Nov. 1962).

Four groups of 15-month-old rats were subjected to 0, 3, 30, or 300 r of continuous γ irradiation per week for 4 weeks, resulting in cumulative doses of 0, 11, 119, and 1152 r, respectively. Weight loss was noted in all irradiated groups. Examination of bar-pressing performance subsequent to irradiation indicated an increase in response rate related to the amount of radiation. Since weight loss was also correlated with radiation, it is not clear to what extent behavioral change is a function of radiation as opposed to weight loss per se. (auth)

1327 PRINCIPLES IN THE CHEMICAL ACTIONS OF IONIZING RADIATIONS. M. Lapenna. Radioterap. Radiobiol. Fis. Med., 17: 87-108(Mar.-Apr. 1962). (In Italian)

After a very brief review of the physical characteristics for various types of radiation used, the chemical foundations of the effects of radiation in water and solutions are considered. The mechanisms of energy degradation in water with decomposition into active radicals and the actions which such radicals exert in the presence and absence of oxygen are discussed. The radical space distribution and its dependence on density and ionization are described. The problem of molecular excitation without radical formation is indicated. Radiation effects on vital micromolecules and in particular on ADN is investigated. In the fundamental biological effect of radiation on cells, the essential effect is on the enzymes, which probably are the chief agents of cell activity. In conclusion, it is confirmed on the basis of research results that biological lesions are initiated by radiochemical action. Whether such lesions are a result of direct action by the radiation quanta on the cell-sensitive volume or whether such lesions are caused by the release of toxic free radicals is open to question. (auth)

1328 COMPARATIVE STUDY OF THE BIOLOGICAL EFFECTS FOUND IN THE MOUSE AFTER WHOLE-BODY IRRADIATION WITH RADIATIONS OF DIFFERENT ENERGIES (200 kv, CESIUM-137, 2 Mev, COBALT-60). R. Miceli, A. Corinaldesi, and C. Rimondi (Università, Bologna). Radioterap. Radiobiol. Fis. Med., 17: 109-28(Mar.-Apr. 1962). (In Italian)

Some biological effects (such as skin characteristics, modifications of weight and hematology, and mortality) found in white mice after whole-body irradiation at different energies were compared. It was observed that there is a constant higher relative biological efficiency for 200 kv radiation and a progressive lower efficiency for radiations from Cs^{137}, 2-Mev electrons, and Co^{60}. On the basis of an LD 50/30, the RBE of the various radiations studied are, with respect to the 200 kev radiations, 0.87 for Cs^{137}; 0.70 for 2-Mev electrons; and 0.67 for Co^{60}. An analysis of the physical and biological factors which can affect the results of experiments on the RBE is given, together with some consideration as to the reasons for the differences found by various workers. (auth)

1329 EFFECTS OF IONIZING RADIATIONS ON THE COLLAGEN. I. THE COLLAGEN FRACTION IN THE IRRADIATED SKIN. R. Vecchioni, V. Gallucci, M. Bottero, and C. Ruffato (Università, Padua). Radioterap. Radiobiol. Fis. Med., 17: 129-36(Mar.-Apr. 1962). (In Italian)

The effect of irradiation on collagen fractions of rat's skin was studied. With the doses and techniques used, it was possible to determine a decrease in the soluble fraction on the ninth and fifteenth day after irradiation, which is followed also by a decrease in the insoluble fraction. The hypothesis that the collagen deficit may be ascribed to the temporary lessening of synthetic cellular capacities unsaturated by the effect of the radiant action was proposed. (auth)

1330 EFFECTS OF IONIZING RADIATIONS ON THE COLLAGEN. II. THE COLLAGEN FRACTION IN IRRADIATED GRANULAR TISSUE. R. Vecchioni, V. Gallucci, M. Bottero, and C. Ruffato (Università, Padua). Radioterap. Radiobiol. Fis. Med., 17: 137-43(Mar.-Apr. 1962). (In Italian)

The effect of radiation on the evolution of the collagen fractions of granular tissue of the rat was studied. A delay in the increase of the soluble collagen fractions, followed by a correspondingly poor formation of insoluble collagen, was detected. It was concluded that such a phenomenon is related to the decreased collagenogenic capacity of the fibroblasts of the exposed area. (auth)

1331 ATTEMPT TO DETERMINE THE OPTIMAL DOSE IN THE RADIOTHERAPY OF HYPERTHYROID DISORDERS WITH I^{131}; CLINICAL RESULTS IN TREATED CASES. O. Jallut (Universität, Zurich). Schweiz. Med. Wochschr., 92: 231-9(Feb. 24, 1962). (In French)

Follow-up studies were conducted in 72 hyperthyroid patients treated with I^{131} 1 to 6 yr previously. The administered dose was calculated in rads by the method of Joyet (Ann. Radiol., in press). In 70% of the cases a euthyroid state was established; in another 10%, hypothyroidism or myxedema developed following I^{131} treatment. I^{131} appeared to induce unique changes in the thyroid; various indices of thyroid function failed to reflect clinical status. The results of I^{131} treatment were not permanent, late myxedema occurring in some patients. Dessicated thyroid treatment was not helpful in cases with I^{131}-induced hypothyroidism. Thyroid function varied widely after I^{131} treatment and it was necessary to wait several months to evaluate results before additional doses of I^{131} was given. Total doses used in these patients varied from 3 to 50 mc, and the mean half-time for the disappearance of I^{131} from these patients was 32 months. In 1 patient treated with 10 mc (5000 rad) a mediastinal spindle-cell sarcoma developed 1 yr later. The possible carcinogenic role of I^{131} is discussed. (H.H.D.)

1332 EFFECTS OF IONIZING RADIATION ON TERRESTRIAL ECOSYSTEMS. George M. Woodwell (Brookhaven National Lab., Upton, N. Y.). Science, 138: 572-7 (Nov. 2, 1962).

The mechanisms that appear to account for the effects of ionizing radiation on the growth of plants are reviewed. Preliminary results are reported from a systematic study of the effects of γ radiation on a terrestrial ecosystem and its components. The ecosystem chosen for this experiment supports a stand of the Long Island pine-oak forest. A 9500 c Cs^{137} source, designed so it can be shielded when desired, was centrally located. Rates of exposure vary from several thousand r/day within a few meters to about 2 r/day at 130 meters. The source has been exposed 20 hr/day since Nov. 22, 1961. Prior to installation of the source, a detailed survey was made on the species composition of the vegetation and on the size and vigor of individual plants. The early effects of radiation exposure are described. (C.H.)

1333 X-RAY-INDUCED CHROMOSOME ABERRATIONS IN THE CORNEAL EPITHELIUM OF THE CHINESE HAMSTER. J. Grant Brewen (Johns Hopkins Univ., Baltimore). Science, 138: 820-2(Nov. 16, 1962).

When the corneal epithelium of the Chinese hamster is irradiated with ionizing radiation in vivo, a rectilinear relationship is observed between the yield of chromosome aberrations and the dose of x rays within a dose range of 10 to 150 r. There is no threshold effect for chromosome breakage down to the 10-r level. The mean breakage rate of 0.00352 breaks per cell per roentgen is in very close agreement with the data obtained on other mammalian tissues, both in vitro and in vivo. (auth)

1334 ELECTRON MICROSCOPIC STUDIES ON THE CORPUS LUTEUM OF TOTALLY IRRADIATED RATS. G. C. Balboni and R. De Dominicis (Università, Florence). Sperimentale, 112: 87-103(Mar.-Apr. 1962).

Adult female nonpregnant rats were submitted to 50- or 300-rad Co^{60} irradiation, and 2 hr later the fine structure of their corpora lutea was examined. After 50 rad the following changes were noted, especially in the so-called dark cells: swelling of the nucleus, thickening of and irregularities in nuclear membrane with loss of its double-lamellar structure, clumping of chromatin, and swelling of mitochondria. Subendothelial and intercellular spaces are enlarged, presumably on account of the edema produced by irradiation. After the 300-rad dose these changes are more pronounced and in addition the nuclei show contraction, mitochondrial structure is distorted, endoplasmic reticulum is fragmented, and cavities are present in the lipid secretory granules. The results show that even relatively low radiation doses induce significant changes in corpus luteum cells as early as 2 hr after irradiation. (H.H.D.)

1335 SOME OBSERVATIONS ON DOSAGE IN IRRADIATION OF PITUITARY ADENOMAS. Magnus I. Smedal. Surg. Clin. North Am., 42: 603-11(June 1962).

A survey was made of 23 cases, in which x-ray therapy was given to the sella area in repeated or multiple series totaling 5500 to 9500 r, to determine whether this amount of radiation is safe and whether an optimum dosage can be predicated. The optimum dosage for pituitary adenoma is 4000 r to the sella in a single series. Three cases of malignant pituitary tumors were controlled 6, 9, and 12 yr respectively with doses of 7400 to 7900 r in 2 series of treatments. In 4 patients operated on after total dosages of 5400, 5900, 6100, and 9000 r respectively, no radiation change was found in the removed tissues. Necropsy in 2 other patients showed no radiation changes after 7140 and 7200 r. The clinical evidence also indicates that in the dosage range utilized in this group of patients, no untoward developments have occurred as a result of x-ray therapy. Hemorrhage occurred in 1 pituitary adenoma 2.5 yr after an initial dose of 4000 r, but this was not necessarily related to x-ray treatment. Failure to obtain a satisfactory result with 4000 r in benign tumors suggests the presence of a cyst or hemorrhage. In cases of benign tumor, there should be a wait of at least 1 yr after administration of 4000 r to determine results before continuation of x-ray treatment. (H.H.D.)

1336 ON THE INFLUENCE OF IRRADIATION ON THE COMPOSITION OF SERUM PROTEINS. Ernst Waldschmidt-Leitz and Lorenz Keller (Heiligenberg Instituts, Ger.). Z. Physiol. Chem., 323: 88-92(1961).

Rabbits were irradiated with 700 r and serum protein fractions were examined electrophoretically 11 and 14 days later. The most marked changes in protein fractions were noted on the 11th day, at which time the relative percentage of albumin had fallen to 44 compared with 61% in nonirradiated controls; γ-globulin had fallen to 4 from 12%; and α- and β-globulins had increased to 34 from 10% and to 18 from 17%, respectively. The electrophoretic mobility and amino-acid composition of albumin were unaffected by irradiation, but some changes were noted in the globulin fractions. The cystine-cysteine content of α-globulin was markedly decreased (to < 0.2 from 2.6%) and similar but less pronounced decreases also occurred in β- and γ-globulins. Histidine and lysine contents of α-globulin fell slightly and increased in the other 2 globulins. The results indicate that ionizing radiation causes changes in the synthesis or extravasation of serum proteins as well as the decomposition of some of them. Destruction of cystine may be related to the radioprotective effect of cysteine and cysteamine. (H.H.D.)

Radiation Sickness

1337 ON AN INCREASE OF THE RADIOPROTECTIVE ACTION OF S-β-AMINOETHYLISOTHIURONIUM · HBr BY DIMETHYLSULFOXIDE. E. Schroeder and R. Huber (Forschungsgemeinschaft der Deutschen Akademie der Wissenschaften, Berlin). Acta Biol. Med. Ger., 9: 62-6(1962). (In German)

The survival rate and survival time were determined in mice irradiated with whole-body doses of 1000 and 1300 r, respectively, and treated with S-β-aminoethylisothiuronium bromide (AET), with and without dimethylsulfoxide. In irradiated untreated mice receiving 1000 r, all animals were dead by the 12th postirradiation day. In mice pretreated with 6 mg. AET, ~25% survived beyond the 30th day, and when 95 mg. dimethylsulfoxide was given with the same amount of AET the 30-day survival rate exceeded 50%. In mice irradiated with 1300 r and given both compounds the mean survival time was 13 days compared with 9 days in rats given AET alone. Half these doses of both compounds were also effective but to a lesser extent. The promoting effect of dimethylsulfoxide on the radioprotective action of AET probably does not involve chemical interaction between the 2 compounds. However, since dimethylsulfoxide is a good solvent medium, it may ensure a better distribution of AET throughout the body and thus enhance its protective action. (H.H.D.)

1338 CHRONIC LYMPHOCYTIC LEUKEMIA AND RADIATION THERAPY. James C. Cook and Walter Romano (Harper Hospital, Detroit). Am. J. Roentgenol., Radium Therapy Nucl. Med., 88: 892-901(Nov. 1962).

One hundred and fifty cases of chronic lymphocytic leukemia seen from 1922 through 1960 were analyzed. The average age of the males was 56 years and of the females 58.4 years, giving a general age of 56.7 years. The amount of roentgen radiation delivered and the various survival times were studied, and it is definitely shown that those patients who survive longest need less therapy and have a more chronic type of disease or a greater natural resistance to its effects. The results of external regional roentgen therapy in 117 patients with active disease are presented both as to long term survival time and as to response at the end of 3 and 12 month periods. These results are compared with those of similar series treated with other modalities as reported in the literature. The survival rate was found to be similar whether radiation was given to the whole body by external means or P^{32}, or whether regional external irradiation was used. Median survival times for living and deceased patients are also presented. No increase in longevity was found in patients

having received maintenance therapy. An attempt was also made to compare the short term patient response to radiation therapy with that to the chemotherapeutic agents, particularly chlorambucil. No advantage was noted over that obtained with radiation therapy. In the case of chemotherapy it will be necessary to judge the long term results at a later date. (auth)

1339 ROENTGEN TREATMENT OF CHRONIC LEUKEMIA. William P. Murphy and Isabel Howard. Am. J. Roentgenol., Radium Therapy Nucl. Med., 88: 902-8(Nov. 1962).

Results are reviewed from an evaluation of the effectiveness of roentgen radiation in the treatment of 107 patients with chronic leukemia. Sixty of the group were classified as granulocytic and 47 as lymphocytic leukemia cases. The number and percentage of 3, 4, 5, and 7 year survivors in both groups are tabulated according to the treatment method. Best results were obtained in both groups by use of the spray technique of irradiation, and best results were obtained in the lymphocytic group. The majority of the patients were remarkably well and able to carry on their usual activities throughout most of their illness. The cause of death in 69 of 105 patients was established as other than leukemia. (C.H.)

1340 INTESTINAL STENOSIS FOLLOWING RADIATION THERAPY. A ROENTGENOLOGIC-PATHOLOGIC STUDY. David E. Perkins and Harlan J. Spjut (Washington Univ., St. Louis). Am. J. Roentgenol., Radium Therapy Nucl. Med., 88: 953-66(Nov. 1962).

The clinical entity of radiation stenosis of the bowel is briefly reviewed. Nine new cases are added to the literature. The dangers of mistaking this entity for persistent cancer is noted. The radiologist has jurisdiction over the essential means by which the diagnosis can be made, namely, the barium enema examination. The roentgenographic and pathologic features are presented. The presence of foam cells in the subintimal areas of small arteries is mentioned as being a possible specific finding in vascular damage from radiation. A longer and curved probe scintillation counter rather than those currently in use would give a more accurate location and reading of the highest rectal and sigmoid dose delivered by the radium applicator in the treatment of carcinoma of the cervix. (auth)

1341 LOWERING THE SKIN TEMPERATURE OF THE IRRADIATED FIELD. COLD WATER CIRCULATION THROUGH A LUCITE CONE FOR SKIN SPARING WITH CONVENTIONAL ROENTGEN RAYS (300 kv). Edwin J. Liebner, Walter S. Moos, Martin Hochhauser, and Roger A. Harvey (Univ. of Illinois, Chicago). Am. J. Roentgenol. Radium Therapy Nucl. Med., 88: 976-87(Nov. 1962).

In 31 cases of carcinoma of the cervix, temperatures were lowered to 50 to 55°F in the treatment area of the lower right abdomen and the left buttock during irradiation. The cooling was performed by means of circulating water through a lucite cone. Initially, cold tap water was used and, more recently, a refrigeration unit. Temperature distribution studies of the cone surface in air and in contact with the patient's skin were made. Various time intervals were studied to indicate the optimal time of irradiation. Nearly all of the patients' subjective complaints were referable to the uncooled treatment side. Eighteen patients showed good objective sparing effect, i.e., less erythema, desquamation, and atrophic changes on the cooled side. Preliminary observations suggest that 1200 to 2000 r could be given additionally to the cooled skin fields, increasing the depth dose at 10 cm from the usual 38 per cent to 50 per cent. The latter equals the depth dose of cobalt-60 teletherapy at 10 cm. (auth)

1342 THE ACTION OF ANESTHETIC AND NARCOTIC AGENTS ON THE ROENTGEN-IRRADIATED MOUSE. D. Winne (Max-Planck Gesellschaft, Gottingen, Ger.). Arch. Exptl. Pathol. Pharmakol., 243: 212-31(1962).

The effect of various drugs on the sleeping time of mice 4 to 5 days after whole-body irradiation with 700 r was investigated. Sleeping time was markedly increased after irradiation with cyclobarbital, pentobarbital, thiopental, hexobarbital, hydroxydione, and tribromoethanol. It was slightly increased with chloral hydrate and methyprylon, but was shortened with urethan in comparison with nonirradiated animals. The changes in sleeping time depended on the irradiation dose and the interval between irradiation and testing. Doses below 700 r gave shorter sleeping time with the effective anesthetics, and prolongation of this time was less when tests were conducted 2 to 3 days after irradiation than 4 to 5 days later. In contrast to results with whole-body irradiation, irradiation of the head with 700 r did not prolong sleeping time with hexobarbital although the same dose applied to the posterior part of the animals did prolong this time. The possible effects of anorexia in irradiated animals on this phenomenon were eliminated by infusions of glucose, which were found not to affect the response. This phenomenon is interpreted on the basis of the slower degradation of the drugs in irradiated animals. Radiation-damaged liver cells presumably detoxify these drugs at a slower rate than cells of intact liver. (H.H.D.)

1343 ATTEMPT AT RADIOPROTECTION OF MICE WITH TWO DERIVATIVES OF ANILINE. M. L. Beaumariage, S. Liebecq-Hutter, and S. A. Freire (Université, Liege). Arch. Intern. Physiol. Biochim., 69: 107-9(Feb. 1961). (In French)

Since aniline was previously found to protect mice against lethal doses of radiation, 2 derivatives (p-chloroethylaniline and diethylaminoethyl-p-chloroaniline) was synthesized and tested in C57 mice irradiated at a rate of 100 r/min. The 1st compound (50 mg/kg) injected 20 min before exposure to 590 r protected 75% of the mice whereas 86 to 100% of the uninjected mice died within 12 days. It was less effective when injected 2 or 10 min before irradiation. It was not effective after 800 r, all mice dying even when injected with 100 mg/kg. The lower dose was somewhat toxic in mice; it produced adynamia, hypertension, hypothermia, and cyanosis of mucosae and paws within 20 to 40 min. Methemoglobinemia was apparent within 5 min. When the 2nd compound (72.5 mg/kg) was injected 20 min before 590 r, 33% of the mice survived; at double this dose, survival decreased to 17%. It was more toxic than the 1st compound and, as the results show, offered less protection. Protection with the first compound is apparently explained by the methemoglobinemia and hypothermia it induces, the resulting anoxia reducing the injury caused by radiation. (H.H.D.)

1344 ON THE LOCAL EDEMA PROVOKED BY CYSTAMINE IN THE RAT. P. Franchimont, H. van Cauwenberge, and J. Lecomte (Université, Liege). Compt. Rend. Soc. Biol., 156: 549-52(June 30, 1962).

Injection of this radioprotective compound in the rat foot caused localized edema which could be prevented by pretreatment with promethazine and UML 491. This indicates that cystamine induces edema by liberating histamine and 5-hydroxytryptamine. (H.H.D.)

1345 A CONTRIBUTION TO THE STUDY OF THE PROTECTIVE EFFECT OF CYSTEAMINE AGAINST

LOCAL IRRADIATION. Louis Darcis (Université, Liege). Compt. Rend. Soc. Biol., 156: 745-8(July 28, 1962).

The effectiveness of this compound was assessed on buccal cells of the irradiated jaw of rabbits, given graded doses from 1000 to 3000 r. In untreated, irradiated rabbits the surface area of these cells increased linearly with the dose, 3000 r producing a 4-fold increase in surface area 8 days after irradiation. This increase became maximum between the 4th and 6th day. In rabbits injected intravenously with 100 mg/kg cysteamine immediately before irradiation with 3000 r, the increase in buccal cell area was 2.5 times compared with 4 in untreated controls. A similar, but less marked, protection of the cells irradiated with 2500 r was afforded by cysteamine. (H.H.D.)

1346 RECOVERY OF LETHALLY IRRADIATED DOGS FOLLOWING INFUSION OF AUTOLOGOUS MARROW STORED AT LOW TEMPERATURE IN DIMETHYLSULPHOXIDE. John A. Cavins, Shinpei Kasakura, E. Donnall Thomas, and Joseph W. Ferrebee (Mary Imogene Bassett Hospital, Cooperstown, N. Y.). Blood, 20: 730-4 (Dec. 1962).

Sixteen normal young dogs were exposed to 1200 r of Co^{60} radiation over their entire bodies continuously at 5 to 6 r per minute. They were then given intravenous infusions of 1 to 5 billion of their own nucleated marrow cells that had been previously aspirated and stored frozen at −80°C in dimethylsulfoxide. Nine received samples stored in 10% dimethylsulfoxide; all made prompt clinical and hematologic recoveries. Three dogs received samples stored in 5% dimethylsulfoxide; one died. Three received samples stored in 15% dimethylsulfoxide; two died. No toxicity of dimethylsulfoxide was recognized. A disagreeable odor emanated from the injected animals and persisted for a number of hours. Dimethylsulfoxide in 10% concentration was found to be suitable for the preservation of dog marrow at low temperature. (auth)

1347 REACTIONS OF MERCAPTANS. I. FORMATION OF 2-METHYL-2-THIAZOLINE-4-CARBOXYLIC ACID FROM N-ACETYLCYSTEINE. II. A SPECTROPHOTOMETRIC METHOD FOR STUDY OF THE REACTION OF RADIATION-PROTECTIVE MERCAPTANS WITH ARYL DISULFIDES. Homer Alvin Smith, Jr. (Oklahoma State Univ., Stillwater). Dissertation Abstr., 23: 447(Aug. 1962).

I. Methyl 2-methyl-2-thiazoline-4-carboxylate was synthesized and converted to the corresponding acid. The behavior of the carboxythiazoline in various concentrations of mineral acids was studied spectrophotometrically. The cyclization of N-acetylcysteine to form a thiazoline-ring compound in concentrated mineral acids was also studied by this means. N-Acetylcysteine in concentrated mineral acid solutions yielded 2-methyl-2-thiazoline-4-carboxylic acid, which also was obtained by controlled hydrolysis of the corresponding methyl ester. Hydrolysis of methyl 2-methyl-2-thiazoline-4-carboxylate, pK 3.05, in 0.1M sodium hydroxide yielded the corresponding carboxythiazoline in solution, pK 2.20 and 4.95. The carboxythiazoline was hydrolyzed very slowly in 7M hydrochloric acid, but the velocity of reaction increased with decreasing acid concentration to a maximum at about pH 1.7; the products were N- and S-acetylcysteine, as well as cysteine and acetic acid. At acid concentrations below 0.2M, the last two products were formed slowly, and a pseudo-equilibrium could be established between thiazolinium ion, N-, and S-acetylcysteine. Equilibrium constants were determined. II. 4,4′-Dithiobis (benzenesulfonic acid) (I) and 4,4′-dithiobis(1-naphthalenesulfonic acid) (II) were synthesized from sulfanilic and naphthionic acids, respectively. The absorption spectra of I and II and of the corresponding mercaptans were determined. The thiol-disulfide interchange reactions were studied by spectrophotometric means for the reactions of cysteine with I and with II, and the equilibrium constants were determined. The systems had spectra very similar to those of the respective mixed disulfides with cysteine, and it was not possible to determine the concentrations from absorbancy measurements. On the other hand, the mercaptide ions had spectra different from the other species, with maxima at 285 and 348 mμ, respectively, and the concentrations of the corresponding mercaptans could be calculated from the absorbancies at these wavelengths. By appropriate choice of the initial concentrations and of pH, the equilibrium concentrations could be made negligible, and the equilibrium constants determined.

1348 INFLUENCES OF β-MERCAPTOETHYLAMINE (MEA) AND OXYGEN REMOVAL ON THE X-RAY SENSITIVITY OF FOUR STRAINS OF ESCHERICHIA COLI. H. L. Cromroy and H. I. Adler (Oak Ridge National Lab., Tenn.). J. Gen. Microbiol., 28: 431-5(July 1962).

Four strains of E. coli were studied under standardized experimental conditions to determine whether MEA protected all strains to the same degree and to compare the effect of oxygen removal on these strains. In strains B/r (ORNL), B (ORNL), B (Hill), and Bs (Hill), protection by MEA exceeded that observed for oxygen removal by nitrogen bubbling. Although only a slight decrease of protection was found with strain Bs (Hill) when oxygen was removed by nitrogen bubbling, the protection afforded by MEA in excess of that achieved by nitrogen bubbling was similar with all 4 strains. These observations are consistent with the hypothesis that MEA protects in at least 2 ways. One offers protection equivalent to that obtained by nitrogen bubbling; above this a 2nd increment of protection was observed. This 2nd mechanism also may involve oxygen as shown by experiments in which $Na_2S_2O_4$ was used as the oxygen-removing agent. This compound is an excellent oxygen "getter" and protects strain B/r slightly better than oxygen removal by nitrogen bubbling. (H.H.D.)

1349 THE PHARMACOLOGICAL EFFECTS OF SOME RADIOPROTECTIVE AGENTS IN MICE. Victor DiStefano, Janet J. Klahn, and Daniel E. Leary (Univ. of Rochester, N. Y.). Radiation Res., 17: 792-800(Nov. 1962). (TID-15096)

Methods are described for the measurement and recording of blood pressure, gut activity, and respiration in the mouse. Responses to some antiradiation compounds are presented. Differences in reaction to some radioprotectant thiuronium compounds after intravenous administration in mice and cats are described. The intraperitoneal administration of four radioprotectant compounds to mice gave rise to a persistent hypertension. The significance of this finding is discussed. (auth)

1350 THE CHEMICAL PROTECTION OF PSEUDOMONAS SPECIES AGAINST IONIZING RADIATION. B. A. Bridges (Wantage Research Lab., Berks, Eng.). Radiation Res., 17: 801-8(Nov. 1962).

Protection of Pseudomonas species against γ radiation under anoxic conditions was observed with cysteine, glycerol, dimethyl sulfoxide, and thiourea. As the concentration of any of these increased, the dose-modifying factor tended to level off to a maximum value between 2.0 and 2.7. When used in combination, protection by pairs of compounds never exceeded these values. This is interpreted as evidence that they all protect against the same component of radiation damage, probably either that due to the action of aqueous free radicals or that due to hydrogen abstraction. (auth)

1351 RELATIVE VALUE OF THE CRITERIA PERMITTING THE STUDY OF THE RADIATION SYNDROME IN LABORATORY ANIMALS. Roger Ghys (Université Liège). Rev. Can. Biol., 21: 79-94(June 1962). (In French)

The criteria most often used to estimate results for radiations of different nature are determined. Among the tests usable on a large range of doses and not necessitating the sacrifice of the animals, the most significant is the evolution of the number of platelets; the simplest to follow is the weight. Four criteria, used simultaneously, give a maximum of information in spite of their technical simplicity: weight, food consumption, hematocrit, and the number of blood platelets. The syndrome observed after a non-fractionated, whole-body irradiation is described, and its two principal conponents are studied. In the digestive phase, death is caused by the loss of liquids and electrolytes. In the hematological phase, death usually results from the inhibition of the reproduction of one or several basic cellular lines. The symptoms permitting the result of an irradiation to be predicted are given. A favorable evolution is always associated with an active anabolism before irradiation. After irradiation, a hemoconcentration, a large loss of weight, a drop in the rate of hemoglobin by red blood cells, or a marked thrombocytopenia are poor prognostics. A large drop of the polynuclear leukocytes on the second day is always a good sign. (tr-auth)

1352 RADIO-MODIFYING ACTION OF TESTOSTERONE IN RATS EXPOSED TO THE EFFECT OF FAST NEUTRONS OR TO THE INTERNAL IRRADIATION BY BETA PARTICLES OF P^{32}. R. Ghys (The Royal Cancer Hospital, London). Rev. Can. Biol., 21: 95-103(June 1962). (In French)

Male and female August rats were irradiated with a 2-Mev beam of fast neutrons or with an injection of P^{32} (internal irradiation by beta particles). The radiomodifying effects of an injection of testosterone given a week before irradiation were studied. The survival rate, the weight curve, and the use of radioactive iron by the hematopoietic system were determined. The utilization of fast neutrons allows the selective study of the effect of radiation on the digestive syndrome and, consequently, the detection of the effect of testosterone on this syndrome. In this series, a radioprotection was noticed in the female and a radiosensitization in the males. Injection of P^{32} reproduces the symptoms of the medullary phase of the irradiation syndrome. It was established that the injection of testosterone does not modify the metabolism of the radioactive phosphorus injected in carrier-free solution nor, consequently, the dose received by the animals. In this series, testosterone protected the females and sensitized the males. (tr-auth)

1353 ON THE CHEMICAL AND BIOLOGICAL PROTECTION FROM RADIATION INJURIES. Donato Fumarola and Romeo Pantaleo (Università, Bari, Italy). Riv. Biol., 55: 261-72(July-Sept. 1962). (In Italian)

Doses of 100 mg/kg of orotic acid given per os to rabbits for 10 days preceding exposure to 2,000 r x radiation increased survival from 6 hr for controls up to 196 hr for treated animals. The life span of animals exposed to 100 r per day to death was increased from 20 days in control animals up to 41 days by the administration of potassium orotate. The protective effects of vitamins against radiation injuries and the mechanism by which the previtamin orotic acid acts are discussed. (C.H.)

1354 ON THE PATHOGENESIS OF POSTIRRADIATIVE HYPOPROTEINEMIA. H. P. Witschi, S. Baradun and H. Cottier (Tiefenauspital, Bern). Schweiz. Med. Wochschr., 92: 104-10(Jan. 27, 1962). (In German)

To investigate the cause of postirradiation hypoproteinemia in cancer patients, the extravasation of intravenously injected I^{131}-labeled polyvinylpyrrolidone (PVP) was investigated in irradiated mice. PVP-I^{131} was injected 2 to 10 days after whole-body irradiation with 500, 700, 800, or 900 r, and appearance of radioactivity in intestinal contents was followed. As earlier as the 2nd day after irradiation the activity of cecal contents was higher than in nonirradiated controls. Max. activity was reached on the 4th day, and then it declined to near normal by the 8th day with doses up to 800 r. After 900 r the activity reached a higher peak and remained higher longer than after the lower doses. Total serum protein and particularly albumin began to fall by the 2nd day. They returned to normal by the 8th to 10th day after 500 and 700 r, but after 800 and 900 r continued to fall during the 10-day observation period. Globulin fractions rose slightly after the lower doses. Enteric loss of serum proteins, therefore, appears to partially explain postirradiation hypoproteinemia. (H.H.D.)

1355 ANIMAL EXPERIMENTAL STUDIES ON THE PROBLEM OF POSTIRRADIATION EXUDATIVE ENTEROPATHY. H. P. Witschi, H. Huegli, and S. Barandun (Tiefenauspital, Bern). Schweiz. Med. Wochschr., 92: 866-71 (July 14, 1962). (In German)

Previous studies showed that whole-body irradiation of rats and mice with 250 to 1[illegible]00 r caused a progressively increasing loss of proteins from blood into the intestinal lumen. This extravasation of plasma proteins was investigated in mice given single 700- or 800-r doses of whole-body irradiation by following the appearance of intravenously tracers in the cecal contents 2 to 10 days later. These tracers were I^{131}-labeled polyvinylpyrrolidone (PVP) of molecular weight 35,000 and 180,000, triolein-I^{131}, and free I^{131}. By the 2nd day after irradiation the cecal content of all test substances were higher than in nonirradiated controls, and by the 4th day this difference was marked. On succeeding days cecal radioactivity declined with all test substances, but on the 10th day PVP-I^{131} intestinal content rose again. Thus extravasation of macromolecules shows a double maximal response 4 and 10 days after irradiation, whereas small molecules show only a monophasic peak. The PVP loss was 3 to 4 times greater than in nonirradiated mice. (H.H.D.)

1356 LATE RADIATION DAMAGE IN THE URINARY BLADDER OF WOMEN. CLINICAL AND PATHOLOGIC FINDINGS. E. Hradec and K. Motlik (Charles Univ., Prague). Urol. Intern., 14: 65-88(1962). (In German)

Late sequelae in the bladder are described in 22 women who had undergone x-ray or Ra therapy for uterine cancer. In most cases clinical symptoms were absent for many months after treatment, and initially arose as hematuria 9 months to 14 yr later. Incontinence and diminished urinary capacity of the bladder were frequent subsequent signs of damage. In some cases, persistent, long-standing hematuria reflected necrotic changes in the bladder, and in some patients anastomoses between bladder and rectum were formed. In these patients, extirpation of the bladder or plastic surgery was required. Histopathologic studies of these resected bladders showed fibrosis of the connective tissue of the bladder wall and thickening of the overlying epithelial tissue. Muscle cells had been destroyed and replaced by fibroblasts, among which were multinucleated giant cells with bizarre chromatin figures. Inflammatory activity was rarely found and was confined to the upper mucosal layer in ulcerated and necrotic regions. Blood

vessels showed cuffing with round cells and occasional stenosis. Large doses of radiation injured the relatively radioresistant muscle tissue, whereas lower doses affected mainly epithelium of the bladder. (H.H.D.)

1357 SURGICAL TREATMENT OF RADIATION DAMAGE IN THE FEMALE URINARY BLADDER. E. Hradec (Charles Univ., Prague). Urol. Intern., 14: 89-110(1962). (In German)

Repair of late bladder injury, following x-ray or Ra therapy of uterine carcinoma, is described in 22 cases. Early surgical intervention was found to be essential in order to restore partial or complete function in the lower urinary tract. Postirradiation ulcerations of the bladder were resected and primary closure of the defect accomplished. In most cases it was possible to avoid ureterosigmoidostomy and diversion of urine flow into the intestine. Vesico-vaginal fistulae were surgically approached through the bladder with removal of all necrotic and sclerotic tissue, and closure of the bladder defect with viable tissue. Portions of bowel were used to repair large trigone defects. Diffuse bladder damage required resection and repair with bowel tissue, and regressive changes in the mesosigmoid region required replacement with small intestine. In many cases, bladder function was successfully restored. (H.H.D.)

CHEMISTRY

General and Miscellaneous

1358 (AAEC/E-94) THE ION EXCHANGE BEHAVIOUR OF BERYLLIUM SALICYLATE COMPLEXES. J. J. Fardy (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Aug. 1962. 27p.

As part of a general study of the co-ordination chemistry of beryllium, the beryllium salicylate complexes were investigated by ion exchange procedures. The evidence indicates that a neutral 1 : 1 and an anionic 1 : 2 chelate exist in solution under appropriate conditions, and their stability constants were determined by ion-exchange methods. The values of the stability constants were found to be $\beta_1 = 4.97 \times 10^{12}$ and $\beta_2 = 2.63 \times 10^{22}$. (auth)

1359 (ANL-6569) CHEMICAL ENGINEERING DIVISION SUMMARY REPORT, APRIL–JUNE 1962. (Argonne National Lab., Ill.). Aug. 1962. Contract W-31-109-eng-38. 166p.

Research and development progress is reported on chemical-metallurgical processing, fuel cycle applications of volatility and fluidization techniques, calorimetry, reactor safety, energy conversion, determination of nuclear constants, and routine operations. (M.C.G.)

1360 (NP-12163) THE REACTION RATE OF HYDROGEN AND DEUTERIUM AS MEASURED IN A CHEMICAL QUENCH TUBE. Brian C. Swanson (Cornell Univ., Ithaca, N. Y.). [1962]. Contract Nonr-401(25). 32p.

Reprinted from thesis dated June 1962.

A chemical quench tube was built and instrumented in such a way that the reaction rate of hydrogen and deuterium ($H_2 + D_2 \rightleftharpoons 2$ HD) could be measured. The main innovation was the use of a solenoid-actuated valve to isolate the reacting gas and prevent it from mixing with the driver gas. The reaction rate at 1500 to 1850°K was found. At 1600°K, $k_1 = 8 \times 10^5$ liter mole^{-1} sec^{-1}. It was shown that the data could be fitted to a line giving a heat of reaction of 60 kcal/mole, which is the generally accepted value. (auth)

1361 (TID-17188) VIBRONIC INTERACTIONS IN METAL-HEXAFLUORIDE MOLECULES. G. L. Goodman (Argonne National Lab., Ill.); B. Weinstock (Ford Motor Co., Dearborn, Mich.); and M. Fred (Argonne National Lab., Ill.). Aug. 1962. Contract W-31-109-eng-38. 5p. (UAC-6787)

Interpretation of the structure and kinetics associated with metal-hexafluoride molecules of the third transition series is discussed. Spectral investigations revealed a primarily tetragonal distortion which occurs independent of the Jahn-Teller theorem in applications at the lowest energy levels. The reason for this lowered symmetry apparently is a crystal packing consideration. The lower lying Γ_8-multiplet of ReF_6 is split into two Kramers doublets, separated by 30.4 cm^{-1}. Predicted splittings for ReF_6 and IrF_6 are tabulated along with observed splittings. Other discussion is presented concerning the calculation of vibronic effects. (J.R.D.)

1362 (AEC-tr-5477) REDUCTION OF CERIUM TRICHLORIDE BY HYDROGEN. S. A. Shchukarev and G. I. Novikov. Translated by A. L. Monks (Oak Ridge National Lab., Tenn.) from Zh. Neorgan. Khim., 1: 362-5(1956). 7p.

Experimental methods for the production of $CeCl_2$ are described. Details are included concerning reduction of $CeCl_3$ by H_2 to obtain a product identified as $CeCl_{2.04 \pm 0.05}$. (J.R.D.)

1363 (AEC-tr-5515) REACTIONS OF METAL CARBIDES WITH WATER VAPOR AND ORGANIC VAPORS. J. de Villelume. Translated by L. M. Ferris (Oak Ridge National Lab., Tenn.) from Ann. Chem. (Paris), (12), 7: 265-310(1952). 55p.

The reactions of CaC_2, LaC_2, CeC_2, Fe_3C, Mn_3C, and Al_4C_3 with water vapor and the vapors of methyl and ethyl alochol, and ethyl aldehyde were examined. Data obtained for reactions of various other organic reagents and various acids are also discussed. (J.R.D.)

1364 EFFECT OF pH AND TEMPERATURE ON DEUTERIUM–HYDROGEN EXCHANGE BETWEEN LYSOZYME AND WATER. L. Kanarek, A. Hvidt, J. Léonis, and M. Ottesen (Université, Brussels). Arch. Intern. Physiol. Biochim., 69: 387-8(May 1961). (In French)

Kinetics of this exchange were studied in D_2O-containing aqueous solutions of lysozyme between pH 2 and 8.7. At 0°C the exchange is never complete; it becomes complete at 38° and pH values above 6. A total of 256 H atoms are exchangeable and 130 of these are in the imide groups of the polypeptide chain. Thus, the D-H exchange in lysozyme is a function of pH and temperature. If these results are interpreted in terms of the hypothesis that the exchange is not instantaneous and involves formation of H bonds in the α helix, the helical content of lysozyme approaches 100% at pH 2 and 35% at pH 8.7. However, this interpretation is at variance with the optical rotatory activity of lysozyme. It is likely that some of the exchangeable H atoms are in the side chains of the protein. (H.H.D.)

1365 DEUTERIUM–HYDROGEN EXCHANGE BETWEEN ALTERED LYSOZYMES AND WATER. L. Kanarek, A. Hvidt, J. Léonis, and M. Ottesen (Université, Brussels). Arch. Intern. Physiol. Biochim., 69: 596-7 (Sept. 1961). (In French)

This exchange was studied after treatment of lysozyme with various protein-denaturing agents. When the enzyme is irreversibly altered by heating at 55 to 72° at pH 3.2, fewer H's exchange for D at 0° and pH 3.2 than in the native enzyme. In contrast, more H's are exchangeable in enzyme denatured at 83° than native enzyme when the exchange is carried out at 0 or 38° at pH 3.2. Three fractions of lysozyme, separated chromatographically after treatment with saturated urea solution at 15° and pH 8.5, exchanged fewer H's, but 2 other such fractions exchanged more H's than native lysozyme. It is suggested that heat-denaturation of lysozyme progresses by 2 stages; in the 1st stage (up to 72°) a more compact structure is formed and in the 2nd (above 72°) a more radical change in the molecule occurs. (H.H.D.)

1366 DEUTERIUM–HYDROGEN EXCHANGE BETWEEN LYSOZYME AND WATER. III. SOME RECENT RESULTS. L. Kanarek, A. Hvidt, J. Léonis, and M. Ottesen (Université, Brussels). Arch. Intern. Physiol. Biochim., 70: 408-9(June 1962). (In French)

Measurement of this exchange in the solid state shows that deuteriated lysozyme fixes in a stable form 12 molecules of D_2O per molecule protein. This ratio remains constant from pH 3.0 to 8.7 although it is more difficult to remove the last molecules of solvent at acid pH. The bound solvent may be adsorbed to the surface of the protein or retained intramolecularly; in the latter case it

may be impossible to remove the last traces of solvent without irreversibly altering the configuration of the enzyme. These alterations may be reflected by an increase in the rate of exchange. The results suggest that a large fraction of exchangable H atoms are in the lateral chains of the lysozyme molecule. Lysozyme deuterated at pH 8.7 and 38° or pH 7.0 and 65° undergoes irreversible changes, whereas it is normally unaffected by these conditions. The heat resistance of deuterated enzyme is lower than that of the hydrogenated form. Similar results were obtained with deuteration of the methylated enzyme at pH 5.2 from 0 to 60°. It is concluded that variations in D-H exchange with changes in pH and temperature actually reflect changes in protein structure. Between pH 3.0 and 8.7, lysozyme retains its secondary structure but adopts a looser configuration, on account of rupture of a few linkages in its tertiary structure. Rupture of these linkages permits a marked increase in motility of the macromolecule. (H.H.D.)

1367 COAGULATION AND SCAVENGING OF RADIOACTIVE AEROSOLS. J. Rosinski, D. Werle, and C. T. Nagamoto (Illinois Inst. of Tech., Chicago). J. Colloid Sci., 17: 703-16(Oct. 1962).

The coagulation constant of nonradioactive and radioactive metallic aerosols produced by an exploding-wire technique was determined experimentally. At early stages of coagulation the coagulation constant of radioactive gold aerosols (2 to 3.5 c/g) was approximately twenty times the mean value of slightly radioactive aerosols (50 to 900 mc/g). The values of the coagulation constant were corrected for deposition on vertical wall surfaces by means of a derived equation. Scavenging of radioactive aerosols was divided into three groups based upon the mechanism of coalescence: (1) dry particulate matter mixed with an aerosol, (2) dry particulate matter formed in the aerosol atmosphere, and (3) hygroscopic and liquid particulate matter formed in the aerosol atmosphere. Brownian motion in the presence of a water vapor concentration gradient around condensing droplets was found to be the most effective scavenging mechanism for slightly radioactive aerosols. (auth)

1368 DEUTERIUM EXCHANGE IN m-DINITROBENZENE. R. J. Pollitt and B. C. Saunders (Cambridge Univ., Eng.). Proc. Chem. Soc., 176(May 1962).

Previous reports indicated that D exchange does not occur with 1, 3, 5-trinitrobenzene in 8N NaOH or in pyridine. These negative results have led to rejection of proton-transfer as a possible mechanism for the color reactions between polynitrobenzenes and bases in dimethylformamide. However, the present experiments show that D exchange does occur with m-dinitrobenzene in dimethylformamide-D_2O in the presence of 0.005N NaOH. The infrared spectrum shows a change (a peak at 2313 cm^{-1} due to C-D stretching) in the product, but melting point, analysis, and ultraviolet spectrum are unchanged. The replacement is largely confined to the 2-position, as shown by proton magnetic resonance spectroscopy, the remaining protons giving an AB_2 spectrum. The infrared spectrum confirmed this, since the C-H in-plane vibration at 1065 cm^{-1} is replaced by the corresponding C-D vibration at 768 cm^{-1}. 1, 3,5-Trinitrobenzene underwent very little D exchange under the same conditions, presumably on account of the greater stability of the trinitrobenzene-OH^- complex. (H.H.D.)

1369 CATALYSIS OF IMIDAZOLE OF DEUTERIUM–HYDROGEN EXCHANGE IN AMIDE N-H GROUPS. Irving M. Klotz and Bruce H. Frank (Northwestern Univ., Evanston, Ill.). Science, 138: 830-1(Nov. 16, 1962).

Imidazole, at concentrations of 0.05M to 0.2M, was found to increase the rate of deuterium-hydrogen exchange in a model amide by 40-fold or more. Since imidazole side-chains occur in proteins, deuterium exchange in these macromolecules may be strongly affected by the presence of these or similar activating groups. (auth)

1370 ELECTROCHEMICAL PREPARATION OF TRIFLUOROACETIC ACID, SODIUM URANIUM(IV) FLUORIDES, AND URANIUM. Donald Rae Allen. Thesis, Gainesville, Univ. of Florida, 1962. 84p.

Three new chemical syntheses are reported. Each of the three requires an electrochemical reaction as a step in its synthesis. 1. Trifluoroacetic acid was prepared by the reaction of 1,1,1-trifluoroethane with air and water vapor in a high voltage alternating electric current discharge. 2. A mixture of high purity sodium uranium (IV) fluorides was prepared from reactions taking place in aqueous solutions. One of the reactions was accomplished by means of a porous cathode electrochemical cell. 3. Sodium metal was used to reduce a fused salt containing uranium tetrafluoride and produce uranium. The reaction was caused to take place by means of an electric current. (Dissertation Abstr., 23: No. 3, 1962)

1371 IMPROVEMENTS IN OR RELATING TO ORGANO METALLIC POLYMERS. Edward Sydney Lane (to United Kingdom Atomic Energy Authority). British Patent 907,775. Oct. 10, 1962.

A process is given for producing polymerized organic compounds of Al, Ti, Zr, or Sn. The process comprises reacting the respective alkyl orthometallate with an alpha-alkenyl ester of a carboxylic acid, preferably vinyl acetate or isopropenyl acetate. The resulting polyvinyl or poly-isopropenyl metallate, when hydrolyzed, has valuable ion exchange properties. (D.L.C.)

1372 THORIA-URANIA SOLS. (to W. R. Grace and Co.). British Patent 908,199. Oct. 17, 1962.

A process is given for producing hydrothermally stable aqueous ThO_2-UO_2 sols which are suited for use as fuel in homogeneous reactors. The process comprises gradually removing by hydrolysis anions from an aqueous solution of $ThCl_4$ and UCl_4 until the solution is free from electrolytes. The removal of the anions may be effected by means of electrodialysis, dialysis, or anion exchange. The sol composition may be varied over a wide range of ThO_2 and UO_2 concentrations, and the sol particles may be clad with SiO_2 to improve the stability. Other advantages are non-abrasiveness, low viscosity, and non-coagulation. (D.L.C.)

1373 METHOD FOR PREPARING GRANULAR GELS. Colin B. Amphlett (to United Kingdom Atomic Energy Authority). U. S. Patent 3,056,647. Oct. 2, 1962.

A method is outlined for preparing granular gels of Zr phosphate and other insoluble inorganic salts for ion exchange applications. The method comprises mixing together solutions of the cations and the anions to form an insoluble gel, flocculating the gel, and drying the gel. Examples of the method are given for the preparation of Zr phosphate, Zr arsenate, Zr tungstate, Zr molybdate, Th phosphate, Th tungstate, Th molybdate, Ti phosphate, hydrous Zr oxide, and hydrous Th oxide. (D.L.C.)

Analytical Procedures

1374 (AERE-AM-85) THE DETERMINATION OF ALPHA ACTIVITY DUE TO URANIUM IN WATER, VEGETATION AND SOIL. C. G. Wallace (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Sept. 1962. 10p.

The uranium is concentrated by precipitation with tannic acid and finally isolated by extraction of the diethyldithiocarbamate complex. The α activity is determined in low background counting equipment. The procedure is suitable for the determination of uranium α activity in river water, vegetation and soil, and the recovery from these materials should be no less than 90%. The method is based on AERE reports R-3498 and R-3499 and on subsequent work which showed that a more efficient concentration of uranium, from EDTA solutions containing aluminum and iron, is obtained by precipitating with tannic acid and pH 6 rather than at the pH of 7.5 used in earlier work. (auth)

1375 (AERE-AM-90) THE DETERMINATION OF PROTACTINIUM-233. J. W. Arden, E. Booth, and M. Perkins (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Sept. 1962. 11p.

Protactinium-233, together with a known amount of protactinium-231, is initially separated on anion exchange resin Deacidite FF. Further purification is achieved by extraction of the protactinium into methyl isobutyl ketone (MIBK) from 6M hydrochloric acid solution, followed by back extraction as the fluoride complex. The extraction cycle is repeated, and the protactinium-233 is then determined by gamma scintillation spectrometry, the chemical yield being assessed by alpha counting the protactinium-231. The method is applicable to solutions of irradiated thorium, thorium-uranium, and thorium-beryllium alloys in sulfuric, nitric, or hydrochloric acid. The procedure is especially suitable when a determination of radioactive zirconium is also required. (auth)

1376 (BM-RI-6091) SPECTROGRAPHIC ANALYSIS OF CERIUM BY A CARRIER DISTILLATION TECHNIQUE. A. B. Whitehead and Howard H. Heady (Bureau of Mines. Reno Metallurgical Research Center, Nev.). Mar. 1962. 27p.

A spectrographic method for the determination of 18 impurities in Ce is presented. The carrier distillation technique is utilized to separate the spectra of impurities from the complex spectrum of Ce. Metal samples are ignited to the oxide, mixed with $AgCl_2$ carrier containing an internal standard, and excited with a 20-amp d-c arc. An additional exposure, made after carrier depletion, provides for the determination of refractory elements. Experiments to determine the best carrier, sample-carrier ratio, electrodes, arc current, exposure conditions, internal standards, and any matrix effect are described. The relative standard deviation of the method at the 20- and 200-ppm levels is about 25 and 15%, respectively. The average relative error is about 20% in the 10- to 1,000-ppm concentration range. (auth)

1377 (BM-RI-6097) ION EXCHANGE SEPARATION AND INSTRUMENTAL ANALYSIS OF IMPURITIES IN RARE-EARTH METALS. H. J. Seim, Joseph L. Johnson, K. R. Stever, and Howard H. Heady (Bureau of Mines. Reno Metallurgical Research Center, Nev.). Feb. 1962. 21p.

An ion-exchange-instrumental analysis technique is described for analyzing impurities at 1 to 1,000 parts per million level in rare-earth metals. A cation-exchange flame photometric method is used for the alkali and alkaline earth groups of metals, and an anion-exchange procedure is used in conjunction with polarographic and x-ray fluorescence techniques for selected transition elements. The standard deviation is about 6%, and the average error, about 5%. (auth)

1378 (CEA-Bib-23) LA DETERMINATION DE L'OXYGENE DANS LES METAUX. (Determination of Oxygen in Metals). M. le Pape (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). 1962. 85p.

Publications concerning the determination of oxygen in metals were collected from 1955 to 1962. One hundred and eighty-eight references, including the abstracts of the paper, are listed. (auth)

1379 (DP-734) X-RAY COUNTER FOR PLUTONIUM SOLUTIONS. George H. Bruber (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.). July 1962. Contract AT(07-2)-1. 15p.

Design features and operating characteristics are given for an instrument that can measure concentrations of 0.0001 to 150 grams of Pu^{239} per liter of nitric acid solution. The solutions are contained in plastic vials, and scintillation techniques are used to count the x rays that originate from Pu^{239}. (auth)

1380 (DP-766) DETERMINATION OF TRACES OF WATER IN FUSED UO_2. Philippe J. P. Chastagner (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Sept. 1962. Contract AT(07-2)-1. 12p.

A manometric method sensitive to 1 μg and an electrochemical method sensitive to 0.2 μg were developed for the determination of 100 ppm or less of water in fused UO_2 powder. Both methods had estimated precisions at the 95% confidence limits of $\pm$20% for 100 μg of water. A temperature of 300°C was required to dehydrate the UO_2 completely. (auth)

1381 (IDO-14591) SILVER SPARK SPECTROGRAPHIC ANALYSIS OF HIGH PURITY WATER. G. W. Dickinson and G. V. Wheeler (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). July 20, 1962. Contract AT(10-1)-205. 11p.

A spectrographic method was developed for the complete cation analysis of high-purity water by spark excitation of the evaporated sample on pairs of silver electrodes. The procedure is fast and precise, with a minimum of sample handling and adequate sensitivity for determining very small amounts of trace impurities. (auth)

1382 (IEA-53) DETERMINACÃO DE URÂNIO, TÓRIO, NIÓBIO E TÂNTALO EM ALGUNS MINÉRIOS URANÍFEROS DE ARAXÁ. (Determination of Uranium, Thorium, Niobium and Tantalum in Some Uraniferrous Minerals from the Araxá Area). Alcidio Abrão and Laura T. Atalla (Brazil. Instituto de Energia Atomica, São Paulo). Aug. 1962. 35p.

Ores from the Araxá area, Minas Gerais, Brazil were analyzed. The samples analyzed could be considered as mixtures of pyrochlores, phosphorite and apatite; they contained titanium, niobium, tantalum, phosphorus and calcium, with small quantities of iron, manganese, uranium, rare earths (cerium), and thorium. Analyses were made for the elements of greater importance: uranium, thorium, niobium, tantalum, titanium, and phosphorus. Previous experiments had shown that a digestion with perchloric-nitric acid mixture, solubilizing the total uranium, was advantageous over aqua regia digestion or fusions. Uranium was extracted with tributylphosphate (TBP), diluted with carbon tetrachloride, and determined by polarographic technique. Some experiments were performed on solubilization of the ores with a perchloric–nitric–hydrofluoric acid mixtures and subsequent extraction of uranium with TBP, the interference of hydrofluoric acid being minimized by controlled addition of aluminium nitrate. Niobium and

tantalum were first determined together by the tannic acid procedure of Schoeller applying some corrections for titanium after its determination in the total oxides (Nb-Ta-Ti). The Schoeller procedure applied to those ores gave high results for Nb + Ta when compared with the tantalum results obtained by neutron radioactivation analysis and the niobium results from polarography. For the radioactivation analysis the oxides obtained by burning the tanninc acid precipitate were submitted to the neutron flux of the São Paulo IEA-R1 Reactor. Tantalum was determined by comparing the area of its photoelectric peak (Ta^{182}, half life 111 days, gamma energy of 0.06 and 1.22 Mev) with that of a tantalum standard irradiated simultaneously in the same geometry, using a single-channel gamma spectrometer. Niobium was determined by the polarographic technique using the cathodic reduction wave of the EDTA-Nb complex at pH 2 to 3, after fusion of the oxides with KOH in a Pyrex glass tube with good results and without loss of niobium. Thorium was measured spectrophotometrically with thoron; it was coprecipitated with the calcium existing in the sample with oxalic acid, was then collected with iron hydroxide, followed by a coprecipitation with lanthanum oxalate, and finally separated from lanthanum by solvent extraction with mesityl oxide in the presence of nitric acid and aluminium nitrate. The whole analytical procedure was controlled by using Th^{234} tracer, the final recovery of Th being about 95% (from solubilized ore until spectrophotometric readings). Seven tables are given with the results of various elements analyzed in eight different flotation fractions of the ores in which were found U_3O_8 varying from 0.01 to 0.04%, $(Ta + Nb)_2O_5$ from 0.01 to 0.5%, Ta_2O_5 from 0.003 to 0.07%, Nb_2O_5 from 0.01 to 0.4%, ThO_2 from 0.02 to 0.1%, and P from 2.1 to 13.8%. (auth)

1383 (KAPL-M-FHG-1) X-RAY ANALYSIS METHODS APPLIED TO THE B_4C–SiC SYSTEM. Franklin H. Guzzetta (Knolls Atomic Power Lab., Schenectady, N. Y.). June 29, 1962. Contract W-31-109-eng-52. 9p.

A method was developed whereby a B_4C-SiC specimen can be quantitatively analyzed. The x-ray analytical technique, which depends on the ratio of the intensities of the B_4C peak at $2\Theta = 23.5°$ and the SiC peak at $2\Theta = 60°$, has a precision of ±3%. The peak intensities were obtained via a Picker x-ray diffractometer. Another completely independent result of this investigation is that the presence of SiC has no effect on the x-ray method of determining the stoichiometry of boron carbide. (auth)

1384 (PG-Report-261) ANALYTICAL METHOD FOR THE DETERMINATION OF THE URANIUM CONTENT AND SPECIFIC GRAVITY OF PURE URANYL NITRATE CONCENTRATES. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1962. 5p.

A measured volume of the concentrate at 80°C is weighed and the specific gravity calculated relative to water at 20°C. The measured volume of concentrate is diluted to a known volume, an aliquot taken, and the uranium content determined gravimetrically. (auth)

1385 (PG-Report-351) ANALYTICAL METHOD FOR THE DETERMINATION OF FLUORINE, NITROGEN AND URANIUM HEXAFLUORIDE IN GAS MIXTURES. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1962. 16p.

UF_6 is separated from the gas mixture, and after hydrolysis is determined by gamma absorptiometry or by absorptiometry in the visual range. Fluorine, by reaction with sodium chloride, quantitatively liberates chlorine which is absorbed in sodium hydroxide and determined as hypochlorite. Nitrogen is collected unchanged and measured volumetrically in a gas burette. (auth)

1386 (PG-Report-366) ANALYTICAL METHOD FOR THE DETERMINATION OF KEROSENE DEGRADATION PRODUCTS IN MIXTURES OF TRIBUTYL PHOSPHATE AND KEROSENE (INFRA-RED ABSORPTION SPECTROMETRY). (United Kingdom Atomic Energy Authority. Production Group, Windscale, Sellafield, England). 1962. 5p.

The sample is washed with water and optical density measurements made at 1558, 1637, and 1735 cm^{-1}. The absorption at these frequencies is ascribed to the C-NO_2, O-NO_2, and C–O groups respectively and is used as a measure of the concentration of kerosene degradation products in the sample. If uranyl nitrate is present in the sample it is removed by washing with sodium carbonate solution before measuring the absorption of the radiation. The method is designed to give an arbitrary measure of the amount of kerosene degradation products in nominally 20% tributyl phosphate in kerosene mixtures. (auth)

1387 (PG-Report-367) A MANUAL FOR THE PREPARATION OF SOLUTIONS FOR VOLUMETRIC, ABSORPTIOMETRIC AND RADIOACTIVATION ANALYSIS, BUFFER SOLUTIONS, GAS TESTING REAGENTS AND TEST PAPERS. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1962. 36p.

Instructions for the preparation of standard solutions, buffer solutions and special reagents used in analytical laboratories of Chemical and Metallurgical Services Department, Springfields Works are presented. (auth)

1388 (PG-Report-372) ANALYTICAL METHOD FOR THE DETERMINATION OF PLUTONIUM IN SOLUTIONS CONTAINING LARGE AMOUNTS OF IRON AND CHROMIUM (LANTHANUM FLUORIDE CO-PRECIPITATION). (United Kingdom Atomic Energy Authority. Production Group, Windscale, Sellafield, England). 1962. 5p.

Plutonium is co-precipitated with lanthanum fluoride. The precipitate is dispersed evenly on a stainless steel counting tray and the α activity measured using standard α-scintillation counting equipment. The equipment was calibrated against standard sources. The method was designed for solutions containing only small amounts of plutonium and uranium, but which contain large amounts of iron and chromium. (auth)

1389 (PG-Report-373) ANALYTICAL METHOD FOR THE DETERMINATION OF PLUTONIUM IN REACTOR FUEL PROCESSING PLANT SOLUTIONS (LANTHANUM FLUORIDE CO-PRECIPITATION). (United Kingdom Atomic Energy Authority. Production Group, Windscale, Sellafield, England). 1962. 6p.

Plutonium is co-precipitated with lanthanum fluoride. The precipitate is mounted on a stainless steel counting tray and the α activity measured using standard α scintillation counting equipment. The equipment is calibrated against standard sources. (auth)

1390 (PG-Report-380) ANALYTICAL METHOD FOR THE ABSORPTIOMETRIC DETERMINATION OF CHROMIUM IN URANIUM OXIDES AND URANYL NITRATE CONCENTRATES. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1962. 6p.

The U oxides are dissolved in nitric acid, and the uranyl nitrate concentrates dissolved in water. Chromium is oxidized to dichromate and determined absorptiometrically as its diphenyl carbazide complex. The method as written is suitable for a concentration range of 0 to 160 ppm Cr. (J.R.D.)

1391 (TID-17030) THE SPECTROCHEMICAL DETERMINATION OF MOLYBDENUM AND VANADIUM IN URANIUM TETRAFLUORIDE. M. G. Atwell and H. A. Heller (National Lead Co. of Ohio, Cincinnati). Sept. 1, 1962. Contract AT(30-1)-1156. 24p.

Procedures are presented for the spectrochemical determination of V and Mo in UF_4. Spectral interference from U is avoided by the use of a carrier composed of a fused mixture of one part Li_2CO_3 and two parts SiO_2. Germanium, which is incorporated in the carrier material, serves as a spectrographic internal standard for the determination of Mo. The Li in the carrier is used as the internal standard for the separate determination of V. The preparation of the carrier material is described in detail. The minimum concentrations of Mo and V that can be determined by these methods are 0.4 ppm and 0.3 ppm, respectively. The limits of error for an individual analysis, based on the average of duplicate determinations, were found to be ±13.5% for Mo and ±8.0% for V (95% confidence level) in the 0.5 to 1 ppm range. (auth)

1392 (CEA-tr-X-457) ANALYSE QUANTITATIVE SPECTROGRAPHIQUE DES ACIERS FAIBLEMENT ALLIÉS. (CÉRIUM, LANTHANE, PRASÉODYME, NÉODYME). (Quantitative Spectrographic Analysis of Steels Weakly Alloyed. (Cerium, Lanthanum, Praseodymium, and Neodymium)). Che Chen Li and Yu Wei W. Translated into French from Chin Shu Hsüeh Pao, 4: 81-5(1959). 16p.

A series of experiments on the chemical and spectrographic analysis of steels are described. Dissolution and electrolytic methods were used. The spectrographic analysis is described in some detail. The results show that the chemical separation limits the possibilities for spectrometric analysis for rare earths. The method can be used, however, to determine the concentration of carbon, manganese, chromium, tungsten, and nickel. The method used for the determination of rare earths however, is efficient to 0.001% in weight. (J.S.R.)

1393 (EURAEC-364) APPLICATION OF TRANSIENT ELECTROCHEMICAL METHODS TO THE CHEMICAL ANALYSIS OF PRODUCTS CONCERNING NUCLEAR CHEMISTRY. Special Report No. 1 (2nd Part). (Brussels. Universite). May 1962. Work performed under United States–Euratom Joint Research and Development Program. Contract 018-60-7RDB. 36p. A translation.

Studies are being made to show how the prepolarization potential can influence the morphology of E(t) curves. An investigation was made of depolarized electrodes when two depolarizers are simultaneously present in solution. Inhibition was also studied. A method is proposed for quantitative analysis of a mixture of two depolarizers, provided that they discharge at slightly different potentials. This method, made possible by the use of prepolarization, is based on the equalization of the current consumed by the first discharge. A mathematical process was developed which makes it possible to correct the errors made in the equalization system. The cases in which inhibition was purely steric and in which the phenomenon of inhibition by diminution of the free surface rate was accompanied by a double-layer electrostatic effect were considered. Application of the inhibition phenomenon in elimination of the maxima by adsorption of organic substances is discussed. (M.C.G.)

1394 A METHOD FOR THE SIMULTANEOUS MEASUREMENT OF THE RADIOACTIVITY OF PROLINE-C^{14} AND HYDROXYPROLINE-C^{14} IN BIOLOGICAL MATERIALS. Beverly Peterkofsky and D. J. Prockop (National Heart Inst., Bethesda, Md.). Anal. Biochem., 4: 400-6(Nov. 1962). (In English)

A method is described for the simultaneous determination of radioactivity in proline-C^{14} and hydroxyproline-C^{14} derived from biological materials. The method involves oxidizing both imino acids with chloramine-T and then selectively extracting the oxidation products into toluene. Of the amino acids derived from proline in biological systems, glutamic acid did not interfere at all while ornithine gave rise to an oxidized product which was toluene extractable to some extent. The method is extremely useful in studying the metabolism of hydroxyproline-containing proteins, where interference from ornithine is of no major importance. (auth)

1395 A SIMPLE SCINTILLATION COUNTING TECHNIQUE FOR ASSAYING $C^{14}O_2$ IN A WARBURG FLASK. Donald R. Buhler (Upjohn Co., Kalamazoo, Mich.). Anal. Biochem., 4: 413-17(Nov. 1962). (In English)

A simple procedure is described for trapping the respiratory $C^{14}O_2$ on KOH-moistened paper in the Warburg center well in a manner which permits simultaneous measurement of oxygen uptake and subsequent liquid scintillation counting of the resulting moist paper strip. The procedure eliminates the cumbersome drying of papers and injection of alkali. The results of several analyses are presented. (P.C.H.)

1396 USE OF γ-SPECTROSCOPY FOR THE DETERMINATION OF BERYLLIUM, BORON, AND FLUORINE IN ORE BENEFICIATION PRODUCTS ON THE BASIS OF THE γ-RADIATION ACCOMPANYING THE INTERACTION OF THE NUCLEI OF THESE ELEMENTS WITH α-RADIATION. I. N. Plaksin, M. A. Belyakov, and L. P. Starchik. At. Energ. (USSR), 13: 374-6(Oct. 1962). (In Russian)

Analytical determination of the elements occurring in ores by means of the (α,n) reaction suffers from the lack of selectivity, as the ores may contain several elements, e.g., Be, B, F, or Li, possessing high cross section for this reaction. On the other hand, making use of the γ radiation of the (α,n) and the (α,p) reaction products with the nuclei of these elements, a satisfactory selectivity may be obtained in combination with γ spectroscopy, for determining the Be, B, or F content of the ores. The $Be^9(\alpha,n)C^{12}$ reaction yields an excited C^{12} nucleus which emits hard 4.45- and 7.65-Mev γ quanta; the nuclear reaction products of α particles with F, B, or Li do not yield such high-energy γ quanta. The $F^{19}(\alpha,n)Na^{22}$ and $F^{19}(\alpha,p)Ne^{22}$ reactions taking place upon irradiation of F by α particles emit 0.62, 1.24, and 1.5-Mev γ quanta; similarly, B nuclei yield 2.3- and 3.8-Mev γ quanta. A two to five microcurie Po^{210} source was used together with a NaI(Tl) crystal as the detector for analysis of a beryl + CaF_2 mixture; the composition of the ore mixture was derived from the ratio of the counting rates of the characteristic γ quanta. (TTT)

1397 DETERMINATION OF URANIUM IN ITS OXIDES AND SALTS. MODIFICATION OF THE METHOD OF KINUNNEN AND WANNERSTRAND. B. Budeshinski, A. Bezdekova, and D. Vrzalová. Collection Czech. Chem. Commun., 27: 1528-32(July 1962). (In Czech)

A method for the determination of the total U in its oxides and salts was perfected. The method is based on the reduction of U^{6+} by sodium hydrosulfite in the presence of (ethyldiamine)tetraacetic acid and subsequent titration of the excess of these ions with Th^{4+}. (tr-auth)

1398 A MASS SPECTROMETER FOR PRECISE DETERMINATION OF THE RATIO OF DEUTERIUM TO HYDROGEN IN HYDROGEN GAS IN THE REGION OF NATU-

RAL DEUTERIUM CONCENTRATIONS. V. Čermák, V. Hanuš, L. Hládek, Z. Herman, M. Pacák, and L. Schulz (Inst. of Physical Chemistry, Czechoslovak Academy of Sciences, Prague). Collection Czech. Chem. Commun., 27: 1633-8(July 1962). (In English)

The construction of a double beam mass spectrometer is described. A precision of 0.3 to 0.5% in the determination of the deuterium to hydrogen ratio was readily achieved by using a very high extraction voltage in the ion source. (auth)

1399 OSCILLOPOLAROGRAPHY WITH A GIVEN SINUSOIDAL VOLTAGE IN THE STUDY OF FUSED SALTS. Yu. K. Delimarskii and V. I. Shapoval (Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Doklady Akad. Nauk SSSR, 146: 391-3(Sept. 11, 1962). (In Russian)

The study of fused salts by polarography is limited by the slow polarization of a solid electrode (10 to 200 millivolts/min). In some cases the electrolytic reaction products undergo irreversible changes, and the potential is shifted. These difficulties can be overcome by using the method of oscillopolarography, where the anode and cathode processes can be observed over a short polarization period ($dE/dt = 1$ to 5 volts/sec). The reversibility of the process can be estimated from the following relationship: $\Delta E = E_{cat.} - E_{an} = (3.2\ RT/nF)$. A platinum wire ring with d = 0.1 mm can be used as the microelectrode. The surface of the non-polarized, platinum macroelectrode was 1000 times larger. Polarization can be carried out at various potentials by a simple electronic arrangement. A current-voltage oscillogram of Cd^{2+} was carried out in an equimolar mixture of KCl and NaCl at 720°C. $E_{cat.}$ was found to be −0.85 volts, and E_{an} was 0.70 volts for concentrations of Cd^{2+} less than 0.00063 gram-ion/mol. At higher concentrations of Cd^{2+} the anode potential is shifted towards the positive side. The theoretical value of ΔE for a reversible process was calculated, and was found to be in good agreement with the experimental value. The magnitude of ΔE does not depend on the potential of the macroelectrode or of the comparison electrode. The reversibility of an electrode reaction can be readily determined by this method. (TTT)

1400 REMARKS ON THE CALCULATION OF ACTIVATION ANALYSES. H.-G. Doege (Institut für Angewandte Physik der Reinststoffe Dresden). Isotopen Tech., 2: 204-5(July 1962). (In German)

A simplified method for calculating the results of activation determinations, which were carried out by the comparison method, is described. (tr-auth)

1401 SEPARATIONS BY REVERSED-PHASE COLUMN PARTITION CHROMATOGRAPHY WITH KEL-F SUPPORTING TRI-n-OCTYLPHOSPHINE OXIDE. E. Cerrai and C. Testa (CISE, Milan). J. Chromatog., 9: 216-23(Oct. 1962). (In English)

The use of chromatographic columns filled with Kel-F (poly-trifluorochloro-ethylene) supporting concentrated solutions of tri-n-octylphosphine oxide (TOPO) in cyclohexane was investigated. After selecting the best way of preparing the columns, examples are given of the following separations: $Fe^{3+}-Co-Ni-U^{6+}$, $V^{4+}-Ti^{4+}-U^{6+}$, $Mn-Cu-U^{6+}$; $Al-Cu-Fe^{3+}-U^{6+}$ and $Fe^{2+}-Fe^{3+}$. Short columns of Kel-F/TOPO were also used for the isolation and quantitative determination of traces of elements in dilute solutions and in the presence of large amounts of foreign ions. The following examples are discussed: Fe and Co in Ni, U and Th in the presence of 13 foreign ions and Zr in Cu. (auth)

1402 SEPARATION OF THE VALENCY STATES OF SOME ELEMENTS ON PAPER IMPREGNATED WITH ZIRCONIUM PHOSPHATE. M. N. Sastri and A. P. Rao (Andhra Univ., Waltair, South India). J. Chromatog., 9: 250-1(Oct. 1962). (In English)

It was found that strips impregnated with zirconium phosphate can be used with aqueous eluents for the separation of several elements in different valency states. A method for the preparation of the impregnated paper strips is given. A table of R_f values is given for different valency states of Fe, U, Ce, Cr, As, V, Mo, and Hg. (D.L.C.)

1403 PAPER ELECTROPHORETIC SEPARATION OF SOME FISSION PRODUCTS. S. K. Shukla and M. Lederer (Laboratoire Curie, Paris; CNEN, Rome; and CNR, Rome). J. Chromatog., 9: 255-7(Oct. 1962). (In English)

The paper electrophoretic behavior of some fission products in 0.5 N $NaNO_2$ electrolyte was studied in order to see whether Ru^{106} could be separated from fission products. The solution of fission products was heated to convert the Ru complexes into a single, highly charged anionic complex, and paper electrophoresis resulted in the separation of Ru^{106}, Sr^{90}, and Cs^{137} (the last two are cationic) from Zr^{95}, Nb^{95}, Pm^{147}, Tc^{99}, and Ce^{144}. (D.L.C.)

1404 CATALYTIC DETERMINATION OF TRACE AMOUNTS OF VANADIUM. P. R. Bontschev (Sofia Univ., Bulgaria). Mikrochim. Acta, 577-83(Mar. 28, 1962). (In English)

A method is described for estimation of V which depends on the ability of V to catalyze the oxidation of aryl amines. The optimal system for this reaction was found to involve the oxidation of p-phenetidine with $KClO_3$ in the presence of phenol as an activator. E.g., when a 5-ml solution containing 0.2% p-phenetidine citrate, 2% phenol, 1% $KClO_3$, and a trace (>0.05 μg) ammonium metavanadate was heated at 95° for 5 min, the intensity of the red color which developed was found to be proportional to concentration of V present. Longer heating produces a turbid solution. The colored product may be quantitatively extracted with various organic solvents (ethyl ether, benzene, n-pentanol, n-butanol, chloroform), leaving V in the aqueous phase, thus increasing the sensitivity of the reaction. No interference by the following elements was detected: Hg^{2+}, Ag, Bi, Al, As^{5+}, Mn, Co, Ni, Ca, Sr, Ba, K, Na, Ti, Ga, In, Be, Mo, and W. However, a similar catalytic effect was produced by U^{6+}, Cr^{3+}, Cr^{6+}, Fe^{3+}, Cu, and Pt. Details of the procedure are outlined for determination of 0.1 to 8 μg V. (H.H.D.)

1405 X-RAY ABSORPTION DETERMINATION OF SULFUR IN HEAVY OIL BY IRON-55 X-RAYS. Shigemasa Enomoto, Tomihiko Furuta, and Chizuo Mori (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 10: 249-54(Apr. 1961).

The intensity of x rays from an Fe^{55} source passing through a cell containing heavy oil was measured by means of a Geiger-Mueller counter. A 1-Mc Fe^{55} source and a vinyl chloride cell (4 mm in length and having a mylar window 100 μ thick) were used. Disturbances from the high energy γ radiation from a considerable amount of Fe^{59} contamination in the source, caused the experimental sensitivity to become worse than the estimated sensitivity for absorption analysis using the 4-mm long cell. Other elements in the heavy oil had little effect on the determination of S, and the observed error was <0.1% for samples containing <4% of S without correcting for the density and mass ratio of C/H in samples. (OID)

1406 X-RAY FLUORESCENCE AS AN AUXILIARY METHOD TO PAPER ELECTROPHORESIS. P. E. Wenger,

I. Kapetandis, and W. von Janstein (Université, Geneva). Pharm. Acta Helv., 37: 472-89(May-Aug. 1962). (In French)

X-ray fluorescence was applied to the determination of Pb^{2+}, Bi^{3+}, Hg^{2+}, and Sr^{2+} separated by paper electrophoresis with the solvent system using buffered 2,2′-diaminodiethyl ether N,N′-tetraacetic acid as previously described by Wenger, et al. (Mikrochim. Acta, 184(1962)). The method is useful for estimating small amounts of these metal ions; with amounts between 10 and 100 μg the accuracy is ±10%. This method has advantages over the colorimetric method, which requires specially treated paper. Electrophoretic separation of Pb and Bi is best carried out in pH 2.05 buffer for 30 min at 20 v/cm potential gradient. Under these conditions Pb migrates to the cathode and Bi toward the anode. The cations are detected on the paper with H_2S. Pb and Sr ions are optimally separated with pH 5.03 buffer, and Sr is detected with rhodizonic acid. (H.H.D.)

1407 THE DETERMINATION OF TRACES OF ARSENIC AND ANTIMONY IN SAMPLES OF PLATINUM BY NEUTRON-ACTIVATION ANALYSIS. R. A. Killick and D. F. C. Morris (Brunel Coll., London). Talanta, 9: 879-84(Nov. 1962). (In English)

A method is described for the determination of ultramicro quantities of arsenic and antimony in pure platinum. In order to avoid self-shielding differences between samples and standards during neutron irradiation, comparators were prepared by the addition of very small known amounts of arsenic and antimony to analytical samples. Samples of 0.1-g of platinum were taken for the determinations, and a radiochemical separation procedure using carriers was employed to isolate the induced arsenic and antimony activities. Results of analyses of seven samples of platinum are given. Although contents of as little as 10^{-8} g of either arsenic or antimony were determined, the ultimate sensitivity of the method was not approached. (auth)

1408 4-(2-PYRIDYLAZO)RESORCINOL AS A SELECTIVE AND SENSITIVE SPECTROPHOTOMETRIC REAGENT FOR NIOBIUM. R. Belcher, T. V. Ramakrishna, and T. S. West (Univ. of Birmingham, Eng.). Talanta, 9: 943-5(Nov. 1962). (In English)

The reagent 4-(2-pyridylazo)resorcinol, PAR, in the presence of EDTA, gives a color reaction with quinquevalent niobium which is not interfered with by any of the metals which normally accompany niobium. Of some 30 cations examined, only uranium(VI) and vanadium(V) interfered seriously. The reaction provided a sensitive method for the spectrophotoı etric determination of niobium, and is also applicable as a spot-test for amounts of niobium(V) down to 0.1 μg. Even tantalum does not interfere when present in twenty-fold amounts, provided sufficient tartrate ion is added. (auth)

1409 PYROHYDROLYTIC DETERMINATION OF FLUORIDE IN MILLIGRAM QUANTITIES OF PLUTONIUM FLUORIDES. G. S. Rao and M. S. Subramanian (Atomic Energy Establishment, Trombay, India). Talanta, 9: 947-8(Nov. 1962). (In English)

The pyrohydrolytic determination of fluoride, using moist air, is described for the fluoride content of plutonium fluorides on the milligram scale. The results indicate that the method gives a precision and accuracy of about 1%. (P.C.H.)

1410 THE DETERMINATION OF THE D_2O CONCENTRATION IN HEAVY WATER BY THE FLOAT METHOD. Karl Kummerer (Kernforschungszentrums, Karlsruhe, Ger.). Z. Physik, 169: 166-77(1962). (In German)

For the evaluation of float measurements all individual steps of the calculations are comprised under the expression of "precise float formula." From this, simplified approximations can be deduced. Their errors are estimated under little restraining conditions. The rather simple "difference formula" in the range of high D_2O concentration together with a density scale for pure D_2O gained by interpolation suffice for most practical purposes. This is proved by numerical comparison with the precise formula. (auth)

1411 POLAROGRAPHIC RESEARCH ON PLUTONIUM. D. Nebel and K. Schwabe (Zentral institut für Kernphysik, Rossendorf, Ger.). Z. Physik. Chem. (Leipzig), 220: 240-54(1962). (In German)

Pu^{4+} in acetate solution gives, at −0.2V (saturated calomel), a polarographic wave which corresponds to reduction to Pu^{3+}. The wave is proportional to concentration but not reversible. The dependence of the half-wave potential and the diffusion on the temperature and the acetate ion concentration was investigated. For solutions of Pu^{4+} in dilute acids, irreversible waves were obtained at −1V (saturated calomel) whose height in $HClO_4$ between 10^{-4} and 10^{-5}M Pu^{4+} was proportional to concentration and corresponded to maximum possible reduction of the plutonium amalgam. (tr-auth)

1412 UNTERSUCHUNGEN ZUR METHODIK DER GESAMT-β-RADIOAKTIVITÄTSMESSUNG IN WASSERN. (Methods for Determination of Total β Activity in Water). Klaus Haberer. Thesis, Karlsruhe, Ger., Technische Hochschule, 1962. 89p.

Methods of direct and indirect beta activity measurements in water are studied. The detection efficiency depends strongly upon the maximum energy of the beta particles, and a direct measurement of the specific activity is only possible for single known isotopes. For unknown isotopes or mixtures concentration methods are necessary. The results of evaporation measurements depend on the methods for sample preparation and counter calibration. Activity loss during sample preparation was studied with a fission product mixture contained in uranium after irradiation with slow neutrons. For older fission product mixtures in water samples a correction factor of 1.3 ± 0.1 for activity loss due to evaporation was measured. The errors of measurements with K^{40} or Tl^{204} calibrated counters are discussed. (Gmelin)

1413 SPEKTRAL'NYI ANALIZ METALLOV AND SPLAVOV. (FOTOGRAFICHESKII METODY). (Spectral Analysis of Pure Metals and Alloys. (Photographic Methods)). E. S. Kudelya. Kiev, State Publishing House of Technical Literature, 1961. 231p.

A study was made of photographic methods for quantitative spectral analysis used in pure metal and alloy technology. Devices for gas analysis and local spectral analysis are described. 205 references are included. (R.V.J.)

1414 NEUTRON SCATTERING AND SOIL MOISTURE. Charles Page Fisher, Jr. Thesis, Raleigh, North Carolina State College, 1962. 169p.

The history and the state of the art of moisture content and unit weight measurement in soil by radiation techniques is reviewed and an examination made of the errors to be expected when using the various types of nuclear devices as compared to errors reported by others for tests using conventional techniques. No satisfactory mathematical solution was found from available theory describing the distribution of neutrons about a point source in hydrogeneous media. However, measured distributions available from the

work of another investigator are used to show (1) that sand-water and carbon-water systems form boundary conditions that include all soil minerals and (2) the maximum possible effect on measured moisture content due to soil mineral type is approximately 10 percent of the measured value. The equipment used in this investigation did not detect the effect produced when the hydrogen in water changed its state of chemical bonding in the hydration of gypsum plaster. A thermal neutron beam generator that utilized a Ra–Be or Pu–Be source of fast neutrons was constructed and a technique for measuring the total thermal neutron cross section of thin samples developed. The attenuation of the neutron beam followed the law $I/I_0 = e^{-\mu t}$. For water the measured cross section was approximately the same as computed by summing cross sections of hydrogen and oxygen. For paraffin wax the measured cross section was appreciably larger than the sum of component values. A similar relationship was found for soils, the difference increasing directly with bound water content of the soil. Chemical analyses of a number of soils were tabulated from the literature and the weight of water of equal thermalizing power calculated. The water equivalent could be approximated by a constant plus the value of the loss-on-ignition in percent by weight. For the soils tested this value of water equivalent appeared to yield a better estimate of measured total cross section than the value computed by summing the cross sections of the atomic constituents of the soil. It was concluded (1) the total thermal neutron cross section of soil minerals could be approximated by the equation, $\sigma_{total} = 0.0445$ (gram molecular weight)(3.4 + loss-on-ignition in percent) barns per molecule; (2) the effect of soil mineral type on the neutron method of soil moisture content measurement might be neglected thus making a single calibration curve suitable for use on all soils except those containing strong neutron absorbers; and (3) the present neutron moisture meters are not suitable for the investigation of the progress of hydration reactions but can be used to measure the total hydrogen content of hydrated materials. Suggestions for further research in this and allied fields are presented. A technical glossary is provided, and appendices discuss the radiation hazard associated with the use of moisture and unit weight devices; describe currently available commercial equipment; and suggest a statistically valid technique for measuring the total state of moisture content or unit weight in a compacted earth structure. (Dissertation Abstr., 23: No. 3, 1962)

1415 APPARATUS FOR DETERMINING THE QUANTITY OF CONTAMINANT IN A SUBSTANCE. John G. Bayly and William H. Stevens (to Atomic Energy of Canada Ltd.). Canadian Patent 643,448. June 26, 1962.

An infrared analyzer for determining as little as 10 ppm H_2O in D_2O and 10 ppm D_2O in H_2O is designed which is little affected by entrained dirt or bubbles. The operation of the analyzer is described in some detail. (D.L.C.)

Inorganic and Physical Chemistry

1416 (DP-750) THE POLYMORPHS OF UO_3: CONVERSION TO UF_4. Wilmer R. Cornman, Jr. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Aug. 1962. Contract AT(07-2)-1. 12p.

Five crystalline polymorphs of UO_3 (α, β, γ, δ, ζ) and an amorphous phase were converted to UF_4 under two sets of conditions: (1) reduction to UO_2 at 500°C followed by hydrofluorination at 550°C and (2) reduction at 900°C followed by hydrofluorination at 550°C. Representative preparations of the polymorphs were reduced to UO_2 with hydrogen at 500, 550, and 600°C, and the surface areas and O : U ratios of the reduction products were measured. (auth)

1417 (GAT-T-970) HEXAFLUORIDES OF MOLYBDENUM, TUNGSTEN AND URANIUM. II. REACTIONS WITH LIQUID AND GASEOUS DINITROGEN TETROXIDE. J. R. Geichman, E. A. Smith, L. R. Swaney, and P. R. Ogle (Goodyear Atomic Corp., Portsmouth, Ohio). Jan. 29, 1962. Contract AT(33-2)-1. 9p.

Molybdenum and tungsten hexafluorides form the solids nitrosylium pentafluoroxymolybdate(VI) and -tungstate(VI), respectively. Uranium hexafluoride gives nitrosylium hexafluorouranate(V) [$NOUF_6$], the same salt that it forms with nitric oxide. (auth)

1418 (NP-12185) SECTION I. KINETICS OF THE STEAM-CARBON REACTION. Jesse S. Binford, Jr. and Henry Erying. SECTION II. A KINETIC THEORY FOR THE OXIDATION OF GRAPHITE. George D. Blyholder, Jesse S. Binford, Jr., and Henry Erying. Technical Note No. XII. (Utah. Univ. Salt Lake City). Aug. 1955. Contract AF33(038)-20839. 22p.

A description is given of a more satisfactory type apparatus for the study of high temperature (1500°C), low pressure (1 to 100 microns) heterogeneous processes in which one or more products is a gas. The water-gas reaction with carbon was studied in the 900 to 1300°C temperature range. The oxidizing gases were carefully preheated to the reaction temperature. A zero-order reaction with an activation energy of 60.3 kcal/mole was found in the 900 to 1100°C range, changing to a first order process by 1300°C with a considerably lower value for the activation energy. Several possible mechanisms are discussed, including a surface rearrangement of adsorption sites and pre-dissociation of water vapor. A considerable amount of data on the carbon-oxygen reaction was collected from the literature, evaluated, and expressed in such a manner that comparison can be made. A theory is proposed which applied to the complete temperature range in which data was obtained, 350 to 2000°C. In particular, the unusual maximum in the Arrhenius plot is explained on a theoretical basis although the model proposed is not readily adapted to the known structural features of graphite. (auth)

1419 (TID-13975) CRYSTAL STRUCTURE OF $Li_2SO_4 \cdot H_2O$, A THREE DIMENSIONAL REFINEMENT. Allen C. Larson (Los Alamos Scientific Lab., N. Mex.). [1960]. Contract [W-7405-eng-36]. 21p. (LADC-4883)

The structure of $Li_2SO_4 \cdot H_2O$ was refined by the method of least-squares for which accurate three-dimensional x-ray diffraction data measured by counter techniques from an approximately spherical crystal were used. Unit cell dimensions are $a = 5.454$, $b = 4.857$, $c = 8.173$ Å, and $\beta = 107°22'$, and the space group is $P2_1$. A satisfactory empirical method was devised to correct for the effects of white radiation. The sulfate group is a regular tetrahedron with an S–O bond of 1.472 ± 0.010 Å. Although a final R of 3.8% was achieved the data were still not accurate enough to locate the hydrogen atoms. (auth)

1420 (TID-14906) THE DIRECT DISSOLUTION OF METALS IN MOLTEN SALT SYSTEMS. Donald Cohen (Argonne National Lab., Ill.). Dec. 1961. Contract [W-31-109-eng-38]. 2p. (UAC-5905).

A brief description is presented of experiments involving the dissolution of metals in molten salt systems containing NH_4^+. (R.J.S.)

1421 (TID-17033) COPRECIPITATION WITH URANOUS OXALATE. Jacob Block and Louis Gordon (Case

Inst. of Tech., Cleveland). [1961]. Contract [AT(11-1)-582]. 30p.

The coprecipitation of cerium(III) with uranium(IV) oxalate was studied using dimethyl oxalate to precipitate uranium(IV) from homogeneous solution. A limited study was also made using scandium(III) and uranium(IV). These systems obeyed the logarithmic distribution law more closely than the homogeneous distribution law. The distribution coefficient was found to be functionally related to the experimentally determined first-order precipitation rate constants when a trace quantity of cerium(III) was coprecipitated with carrier uranium(IV) oxalate. The coefficient λ was found to be equal to K_T/K_C where K_T, the fractional rate of precipitation of tracer, was determined in the presence of the carrier. The cerium(III)–uranium(IV) oxalate system obeyed a distribution law modified to include ion charge rather than the unmodified Doerner-Hoskins logarithmic distribution law. (auth)

1422 (TID-17044) DETERMINATION OF PORE SIZE DISTRIBUTION OF SOLIDS FROM NITROGEN ADSORPTION DATA. W. G. Ellis and E. A. Brown (National Lead Co. of Ohio, Cincinnati). [1955?]. Contract [AT(30-1)-1156]. 15p.

A method for determining the pore size distribution of catalytic materials was applied to the study of surface properties of noncatalysts such as uranium oxides and fluorides. Computations of the pore size distribution were made from Kelvin equation radii and nitrogen adsorption data. The physical adsorption measurements were made at liquid nitrogen temperature in a modified BET apparatus normally used for the determination of surface area of solids. A study was made to show the relationship between the pore area by this method and by the BET adsorption method. The technique was applied to the uranium oxide and uranium tetrafluoride systems. (auth)

1423 (SCL-T-438) RELATION BETWEEN THE DIFFUSION COEFFICIENT AND THE MOBILITY OF THE F CENTERS IN ALKALI HALIDE CRYSTALS. A. A. Shatalov. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.) from Nauk. Povidomlennya, Kievsk. Univ., No. 1, 15-17(1956). 4p.

With the aid of photography and photometry, the correctness of Einstein's correlation, both for the diffusing F-electrons and F-electrons that are stopped (arrested) by the electric field in NaCl and KCl crystals, is demonstrated by coloration clouds induced in the crystals by an electric field. A state of equilibrium between the diffusional and electric forces is obtained by reversing the electric field. The correlation between the diffusion coefficient and the mobility of the F centers in the crystals is explained by equations. (N.W.R.)

1424 (UCRL-Trans-854(L)) EMISSION STIMULATING ACTION OF THE EXCITING LIGHT IN PHOSPHORS. V. V. Antonov-Romanovskii. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Berkeley) from Izv. Akad. Nauk SSSR, Ser. Fiz., 13: 91-100(1949). 17p.

A series of cases in which the stoppage of growth of the light sum in phosphors is such that the factor which hinders the further accumulation of the light sum appears to be the extinguishing action of the exciting light itself. The behavior characteristics of phosphors during intense excitation are described. Results of experiments with silicate, alkaline-earth, and zinc phosphors are presented. Data indicated that the limiting concentration of the stored light sum is a function of the wavelength of the exciting light. The spectral region of the extinguishing action in general overlaps the spectral region of excitation. (M.C.G.)

1425 ON THE STABILITY OF THE ACETATE, GLYCOLATE AND THIOGLYCOLATE COMPLEXES OF TERVALENT EUROPIUM AND AMERICIUM. Ingmar Grenthe (Univ. of Lund, Sweden). Acta Chem. Scand., 16: 1695-1712(1962). (In English)

Stability constants for the acetate, glycolate, and thioglycolate complexes of tervalent europium and americium were determined in a perchlorate medium of the ionic strength I = 0.5 M and at a temperature of 20.0°C. The europium complexes were studied by a potentiometric method and the americium complexes by a cation exchange method. Quantitative results for the acetate and glycolate systems were checked by an anion exchange study. In all the systems investigated the americium complexes were stronger than the corresponding europium complexes. The difference was most pronounced for the glycolate systems. For both europium and americium the stability constants of the complexes decreased in the following order: glycolate, acetate, and thioglycolate. (auth)

1426 THE UNIT CELL AND SPACE GROUP OF Li_2C_2. D. R. Secrist and L. G. Wisnyi (Knolls Atomic Power Lab., Schenectady, N. Y.). Acta Cryst., 15: 1042-3(Oct. 10, 1962). (TID-15038) (In English)

A brief study was conducted on the structure of a single, monoclinic crystal of Li_2C_2. The cell dimensions were determined to be $a_0 = 7.801 \pm 0.002$ Å, $b_0 = 8.815 \pm 0.005$ Å, $c_0 = 10.865 \pm 0.005$ Å, and $\beta = 76.8 \pm 0.1°$. The space group is either P2, Pm, or P2/m, probably the latter. The unit cell probably contains 18 to 20 molecules. Interplanar spacings are tabulated. (D.L.C.)

1427 UNIT CELL AND SPACE GROUP OF TECHNETIUM CARBONYL, $Tc_2(CO)_{10}$. Daniel Wallach (Univ. of California, Los Angeles). Acta Cryst., 15: 1058(Oct. 10, 1962). (In English)

The structure of $Tc_2(CO)_{10}$ was studied and compared with that reported for $Mn_2(CO)_{10}$ and $Re_2(CO)_{10}$. The unit cell dimensions of $Tc_2(CO)_{10}$ were determined to be $a_0 = 14.73 \pm 0.05$ Å, $b_0 = 7.22 \pm 0.02$ Å, $c_0 = 14.90 \pm 0.02$ Å, and $\beta = 104.6 \pm 0.1°$. The space group is either Ia or I2/a, and the unit cell has four molecules. $Tc_2(CO)_{10}$ is isomorphous with $Mn_2(CO)_{10}$ and $Re_2(CO)_{10}$ and hence is also dimeric. (D.L.C.)

1428 A NEW EUROPIUM OXIDE Eu_3O_4 AND THE ISOTOPE COMPOUND Eu_2SrO_4. H. Baernighausen and G. Brauer (Universität, Freiburg i. B.). Acta. Cryst., 15: 1059(Oct. 10, 1962). (In German)

Eu_3O_4 is formed as a dark-red powder from a finely ground, equimolar mixture of EuO and Eu_2O_3 by heating for 2 hr at 900°C under an inert atmosphere. Eu_2SrO_4 is prepared from a carefully ground, equimolar mixture of Eu_2O_3 and $SrCO_3$ by glowing for 6 hr at ~1000°C in air, and its Debye-Scherrer diagram corresponds with that of Eu_3O_4. The lattice constants for Eu_3O_4 and Eu_2SrO_4 were respectively determined to be: $a = 10.094 \pm 0.003$, 10.133 ± 0.003 Å; $b = 12.068 \pm 0.003$, 12.081 ± 0.003 Å; and $c = 3.500 \pm 0.001$, 3.4979 ± 0.005 Å. For Eu_2SrO_4, the unit cell contains 4 formula units, and the space group is probably Pnam. (D.L.C.)

1429 ANALYSIS OF THE ABSORPTION SPECTRUM OF IBr. I. ROTATIONAL ANALYSIS OF THE NEAR INFRARED BANDS. Lars-Erik Selin. Arkiv Fysik, 21: 479-513(1962). (In English)

In a study of the absorption spectrum of iodine bromide, photographs of the infrared regions are made in high resolution. The fine structures of the bands are resolved, so

that rotational analyses can be carried out. The infrared system is associated with a $^3\Pi_1 \leftarrow {}^1\Sigma^+$ transition. Vibrational and rotational constants are given. The rotational constants thus found are in disagreement with those computed from microwave measurements. In the upper $^3\Pi_1$ state, the numbering of the vibrational levels is found and related to the isotope shift. The Λ-type doubling in the $^3\Pi_1$ state is investigated, and the splitting constant q is found to increase with increasing vibrational quantum numbers. Perturbations in the levels v′ = 30, 31, and 32 are found. (auth)

1430 ANALYSIS OF THE ABSORPTION SPECTRUM OF IBr. II. ROTATIONAL ANALYSIS OF THE RED BANDS. Lars-Erik Selin and Berndt Soederborg. Arkiv Fysik, 21: 515-28(1962). (In English)

A rotational analysis of the IBr red absorption band system is given. The system is found to be associated with a $^3\Pi_{0^+} \leftarrow {}^1\Sigma^+$ transition. Ten bands are analyzed. The numbering of the upper state levels is performed using the isotope shift determined from the rotational structure. An attempt to determine the vibrational constants with the help of the isotope shift is discussed. (auth)

1431 ANALYSIS OF THE ABSORPTION SPECTRUM OF IBr. III. ROTATIONAL ANALYSIS OF THE VISIBLE BANDS. Lars-Erik Selin. Arkiv. Fysik, 21: 529-41(1962). (In English)

A rotational analysis of the main part of the IBr visible absorption band system is carried out. The rotational structure of this system is incomplete and consists of R and P branches extending over narrow regions of J values. Twenty three bands are analyzed, namely those having v′ = 8, 11, 12, 15, 16, 20, 21, 22, and 27. Rotational constants are given. Isotope effects of Br^{79} and Br^{81} are measured only in a few of the bands, so that the v′ numbering cannot be stated with certainty, nor can vibrational constants be given. It is found to be difficult to state whether there is any coincidence between rotational levels that have the same J but belong to the 0^+ or $^3\pi_{0+}$ states. (T.F.H.)

1432 ROTATIONAL ANALYSIS OF THE BLUE-GREEN AND ORANGE SYSTEMS OF SCANDIUM OXIDE. Lars Åkerlind (Univ. of Stockholm). Arkiv Fysik, 22: 41-64(1962). (In English)

A study is made of the rotational structure in the orange and blue-green regions of the spectrum of scandium oxide. The bands analyzed are the 0,0 band of the forbidden transition $A\,^2\Pi - X\,^4\Sigma$ and the 0,0, 1,0, 2,1, and 0,1 bands of the forbidden transition $B\,^2\Sigma - X\,^4\Sigma$. The splitting of the $X\,^4\Sigma$ term is small. The spin splitting of the $B\,^2\Sigma$ state is unusually large. In the $A\,^2\Pi_{\frac{1}{2}}$ state a small perturbation is found. (auth)

1433 ROTATIONAL ANALYSIS OF THE RED AND GREEN-YELLOW SYSTEMS OF LANTHANUM OXIDE. Lars Åkerlind (Univ. of Stockholm). Arkiv Fysik, 22: 65-93(1962). (In English)

Rotational analyses of the red band system (7000 to 8500Å) and the green-yellow band system (5400 to 5900 Å) of LaO are carried out. In the red system, consisting of a $^2\Pi - {}^4\Sigma$ ($A\,^2\Pi - X\,^4\Sigma$) transition, the 0,0 bands, the 1,0 band of $^2\Pi_{\frac{3}{2}} - {}^4\Sigma$, and the 0,1 of $^2\Pi_{\frac{1}{2}} - {}^4\Sigma$ are analyzed. The $^2\Pi$-term is regular. The green-yellow system is a $^2\Sigma - {}^4\Sigma$ transition, designated B → X. The following bands are examined: 0,0, 1,0, and 0,1. The spin-splitting of the $^2\Sigma$-term is considerable. A comparison between the molecules ScO, YO, and LaO is made, and correlations between the molecular and atomic terms of the three molecules are suggested. (auth)

1434 THERMODYNAMIC PROPERTIES OF HEAVY WATER. U. K. Rombusch, W. Barho, G. Ernst, A. Schaber, and D. Straub (Technische Hochschule, Karlsruhe, Ger.). Atompraxis, 8: 339-44(Sept. 1962). (In German)

A new calculation was made of the specific heat of D_2O in an ideal gaseous state. The results obtained are very accurate, largely because account was taken of the effects resulting from the interrelationship between rotational vibration and the inharmonics of normal oscillation. In addition, as many thermodynamic data as possible were collected on liquid and gaseous D_2O; these are presented polynomially in their relationship to temperature. (auth)

1435 THE PREPARATION OF MIXED OXALATE-CARBONATE COMPLEXES OF THORIUM. L. N. Essen and D. P. Alekseeva (Inst. of Physical Chemistry, Academy of Sciences, USSR). Doklady Akad. Nauk SSSR, 146: 380-2 (Sept. 11, 1962). (In Russian)

On mixing 3 grams of thorium oxalate with 3.1 grams of sodium carbonate in 50 ml of water with a mol ratio of $Th(C_2O_4)_2 \cdot 6H_2O : Na_2CO_3 = 1:5$, a clear solution of a Th complex is obtained at room temperature. On adding an equal volume of ethyl alcohol, a precipitate is obtained with a composition of $Na_8Th(C_2O_4)_2(CO_3)_4 \cdot 11H_2O$. With a mol ratio of Th oxalate to Na_2CO_3 of 1:6, the composition of the precipitate is $Na_{10}Th(C_2O_4)_2(CO_3)_5 \cdot 11H_2O$. On evaporating down an aqueous solution at room temperature, the composition was found to correspond to the formula $Na_8Th(C_2O_4)(CO_3)_5 \cdot 11H_2O$. The composition of the compound depends on the method of isolation. The compound $K_4Th(C_2O_4)(CO_3)_3 \cdot 6H_2O$ was isolated at a mol ratio of 1:4, and the compound $K_6TH(C_2O_4)(CO_3)_4 \cdot 6$ to $8H_2O$ was isolated at a mol ratio of thorium oxalate to potassium carbonate of 1:6. All the compounds isolated hydrolyze readily in aqueous solution. (TTT)

1436 ABSORPTION SPECTRUM OF THE HYDRATED ELECTRON IN WATER AND IN AQUEOUS SOLUTIONS. Edwin J. Hart and J. W. Boag (Argonne National Lab., Ill. and Mount Vernon Hospital, Northwood, Eng.). J. Am. Chem. Soc., 84: 4090-5(Nov. 5, 1962).

A transient absorption band with peak at 7000 Å was found in deaerated water and in various aqueous solutions produced a pulse of 1.8 Mev electrons. The band is attributed to the hydrated electron. The rate of decay of the absorption and the effect of various anions, cations, and dissolved gases were studied. Similar absorption spectra produced irradiation were found in concentrated aqueous solutions of ammonia and of methylamine, which resemble the known absorption spectra of solvated electrons in liquid ammonia or in liquid methylamine. (auth)

1437 RADON FLUORIDE. Paul R. Fields, Lawrence Stein, and Moshe H. Zirin (Argonne National Lab., Ill.). J. Am. Chem. Soc., 84: 4164-5(Nov. 5, 1962).

The reaction of trace amounts of radon with fluorine was studied and it was found that radon forms a stable fluoride which is less volatile than XeF_4. The composition of the radon fluoride was not determined. The fluoride can be reduced with hydrogen to quantitatively recover elemental radon. At 200° the compound appeared to be stable in hydrogen, but at 500° and a hydrogen pressure of 800 mm it was completely reduced within 15 min. The tracer quantities of radon fluoride prepared showed no evidence of radiation decomposition from alpha particle emission. (P.C.H.)

1438 NEW ORTHORHOMBIC PHASE IN THE Ru-B AND Os-B SYSTEMS. R. B. Roof, Jr. and C. P. Kempter (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 37: 1473-6(Oct. 1, 1962). (LADC-5347)

By the use of single crystal and polycrystalline x-ray dif-

fraction techniques, isomorphous orthorhombic lattices (space group No. 59) were found in the Ru–B and Os–B systems having lattice parameters of $a_0 = 4.6443 \pm 0.0003$ Å, $b_0 = 2.8668 \pm 0.0008$ Å, $c_0 = 4.0449 \pm 0.0004$ Å, and $a_0 = 4.6832 \pm 0.0001$ Å, $b_0 = 2.8717 \pm 0.0002$ Å, $c_0 = 4.0761 \pm 0.0001$ Å, respectively. The probable empirical formulas are RuB_2 and OsB_2, with two formula weights per unit cell. (auth)

1439 HYDROGEN-DEUTERIUM KINETIC ISOTOPE EFFECT, AN EXPERIMENTAL AND THEORETICAL STUDY OVER A WIDE RANGE OF TEMPERATURE. Terry E. Sharp and Harold S. Johnston (Univ. of California, Berkeley). J. Chem. Phys., 37: 1541-53(Oct. 1, 1962).

An experimental study of the kinetic isotope effect for the reaction

$$CF_3 + CHD_3 - \begin{cases} \rightarrow F_3C-H-CD_3 \rightarrow F_3CH + \ldots \\ \rightarrow F_3C-D-CHD_2 \rightarrow F_3CD + \ldots \end{cases}$$

was carried out between 300 and 700°K, and also the Arrhenius parameters $k = A \exp(-E/RT)$ were obtained for the individual reactions. An especial effort was made to avoid systematic errors, and the precision obtained was good. These data were combined with those of Tschuikow-Roux who studied the essentially same reaction between 1000 and 1800°K, and a detailed test was made of activated complex theory utilizing the method of London-Polanyi-Eyring-Sato with corrections for quantum mechanical tunneling. Sato's parameter was evaluated from activation energy of an analogous reaction so that k_H/k_D and A provided an unambiguous, nonadjustable test of theory. Because reactants were identical for both reactions, all the kinetic isotope effect depended on differences in the two activated complexes. The vibrational frequencies of the two nine-atom models of the complex were evaluated by a computer, programmed to E. B. Wilson's FG-matrix methods, and the effect of replacing the full nine-atom model by simpler five-, four-, or three-atom models was tested. The Arrhenius A factor was enormously sensitive (factor of 10^3) to number of atoms assigned to the model; the three- or four-atom models gave A factors much too high, but the five- or nine-atom models with tunneling corrections were in fairly good agreement with experiment from 300 to 1800°K. It is judged that if one evaluates a potential-energy surface, carries out a full vibrational analysis, and applies a reasonable tunneling correction, then one has in activated complex theory an expression analogous in logic and in usefulness to the perfect-gas theory; that is, broad over-all predictions can be made (in spite of readily identified conceptual flaws) but fine points will always be missed. Any quantitative value in the simplified versions of the theory is open to grave doubt. (auth)

1440 ELECTRON DIFFRACTION STUDY OF THE REMOVAL AND FORMATION IN VACUO OF OXIDE FILMS ON URANIUM AND PLUTONIUM. James T. Waber, Clayton Olsen, and Dawn D. Whyte (Los Alamos Scientific Lab., N. Mex.). J. Electrochem. Soc., 109: 895-902(Oct. 1962). (LADC-3783)

Experiments and the development of apparatus relating to the removal of oxide film and the attempts to prepare an oxide-free surface on uranium are described. Polishing the metal in vacua of the order of 10^{-7} torr appears to be the most successful method. UH_3 and UO_2 were observed to form rapidly on the metal in such vacua. PuO_2 was found to form on plutonium in vacua at pressures of less than 1×10^{-3} torr. The possibility that plutonium hydride also formed was not investigated, because of the similarity in crystal structure and lattice parameter between PuO_2 and PuH_2. (auth)

1441 THE MECHANISM OF THE NIOBIUM REACTION WITH WATER VAPOR AND WITH OXYGEN. P. E. Blackburn (Westinghouse Electric Corp., Pittsburgh). J. Electrochem. Soc., 109: 1142-50(Dec. 1962).

The stability of Nb_2O_5, the rate of reaction of Nb with water vapor, and the mechanism of reaction of Nb with oxygen and water vapor were determined. The so-called breakaway oxidation occurring between 400 and 500°C in oxygen and between 750 and 950°C in water vapor is shown to be caused by nucleation and growth of Nb_2O_5 on NbO_2. (P.C.H.)

1442 ROTATIONAL PERTURBATIONS IN THE INFRARED SPECTRA OF $C^{13}O_2$. C. P. Courtoy (Facultés Universitaires Notre-Dame de la Paix, Namur, Belg.), and E. A. Trialle. J. Mol. Spectry., 9: 339-53(Nov. 1962).

Perturbation for the level 03^11 of $C^{13}O_2$ was studied thoroughly. A theory developed to explain the perturbation was systematically applied to all the energy levels that might be affected by it. For many levels, the rotational constants are perturbed, sometimes even for levels more than 300 cm^{-1} apart. (auth)

1443 THEORETICAL STUDY OF THE ANOMALOUS ROTATIONAL STRUCTURE OF LEVEL 03^11 IN THE ROTATION-VIBRATION SPECTRUM OF $C^{13}O_2^{16}$. M. H. Andrade e Silva and G. Amat (Faculté des Sciences, Paris). J. Mol. Spectry., 9: 354-65(Nov. 1962).

The strong resonance which takes place between 03^11 and 30^00 levels of $C^{13}O_2^{16}$ was studied from a theoretical point of view. It was found that the off-diagonal matrix elements involved in the effect were also responsible for weak perturbations in other rotation-vibration levels of the molecule. (P.C.H.)

1444 MICROWAVE SPECTRUM OF ACETONITRILE-d_3, CD_3CN. Chi Matsumura, Eizi Hirota, Takeshi Oka, and Yonezo Morino (Tokyo Univ.). J. Mol. Spectry., 9: 366-80 (Nov. 1962).

Microwave spectrum for the $J = 2 \leftarrow 1$ transition of the CD_3CN molecule was investigated. The molecular structure was determined from the observed spectra of CD_3CN, $C^{13}D_3CN$, $CD_3C^{13}N$, and CD_3CN^{15}. A number of spectral lines of the molecule in the excited vibrational states, ν_8, $2\nu_8$, $3\nu_8$, $4\nu_8$, $5\nu_8$, ν_7, ν_6, ν_4, and ν_3, were measured and analyzed. The observed l-type doublings and the splittings in highly excited states were well interpreted by the theory. An anomaly in the Stark pattern of the ν_7 excited lines was noticed and explained by the accidental near degeneracy of the ν_4 and ν_7 vibrations. (auth)

1445 VIBRATION-ROTATION INTERACTIONS IN INFRARED ACTIVE OVERTONE LEVELS OF SPHERICAL TOP MOLECULES; $2\nu_3$ AND $2\nu_4$ OF CH_4, $2\nu_3$ OF CD_4. Kenneth Fox (Univ. of Michigan, Ann Arbor). J. Mol. Spectry., 9: 381-420(Nov. 1962).

The theory of the vibration-rotation lines of the first overtones of the infrared active fundamentals of tetrahedral molecules was re-examined. Theory predicts an overtone spectrum consisting of five P, Q, and R branches of roughly comparable intensities provided that the vibrational angular momentum quantum number l is approximately a good quantum number for the complete vibration-rotation Hamiltonian. The band $2\nu_4$ of CH_4 is shown to be consistent with the approximation that the separation of the E and F_2 vibrational substates of the $l = 2$ vibrational state must be small compared with the splittings which arise from the $2B\zeta(P \cdot 1)$ term. If however the separation between the E and F_2 vibrational substates is very large theory predicts an overtone spectrum consisting of single strong P, Q, and R branches with P and R branch spacings of approximately $2B(1 + \zeta)$. These P, Q, and R lines are associated with the

F_2 vibrational substate, and have relative intensities much larger than the lines of the E vibrational substate. The bands $2\nu_3$ of both CH_4 and CD_4 are shown to be accounted for by this limit. The detailed calculations exploit the spherical tensor formalism. In the first case a conventional angular momentum coupled representation, an extension of Hecht's work on the fundamental ν_3, is used in the calculations. In the second case a new representation is introduced which formally has many of the mathematical properties of the conventional representation for an $l = 1$ vibrational state. The tetrahedral splittings in the vibration-rotation levels of $2\nu_3$ of CD_4 are appreciable, and are accounted for very well by the following constants which give the splittings throughout the spectrum: $D_t = 1.1 \times 10^{-6}$ cm^{-1}, $F_{3t} = -1.4 \times 10^{-4}$ cm^{-1}, $\gamma_{3t} = \frac{1}{5}(Z_{3s} + Z_{3t}) = 1.16 \times 10^{-2}$ cm^{-1}. The following linear combinations of effective rotational constants were obtained from the spectrum: From the P and R branches, $B + B_0 + 2(B\zeta_3) = 6.00 \pm 0.02$ cm^{-1}, $B - B_0 = -0.050 \pm 0.004$ cm^{-1}. From the Q branch, $B - B_0 = -0.062 \pm 0.002$ cm^{-1}. In $2\nu_3$ of CH_4 the tetrahedral splittings were quite small, making a quantitative fit more difficult. However, the best fit was obtained with $D_t = 4.5 \times 10^{-6}$ cm^{-1}, $F_{3t} = -1.25 \times 10^{-4}$ cm^{-1}, and $\gamma_{3t} = -5.0 \times 10^{-4}$ cm^{-1}. Also, from the P and R branches, $B + B_0 + 2(B\zeta_3) = 10.76 \pm 0.02$ cm^{-1}, $B - B_0 = -0.063 \pm 0.004$ cm^{-1}; from the Q branch, $B - B_0 = -0.058 \pm 0.002$ cm^{-1}. The spectrum of $2\nu_4$ of CH_4 is extremely complex as a result of the tetrahedral splittings and the overlapping of the five P, Q, and R branches. It was not possible to make definite assignments for the observed lines at this time. (auth)

1446 DETECTION OF METAL ION HYDROLYSIS BY COAGULATION. V. ZIRCONIUM. E. Matijević, K. G. Mathai, and M. Kerker (Clarkson Coll., Potsdam, N. Y.). J. Phys. Chem., 66: 1799-1803(Oct. 1962).

The charge of the cationic species in dilute zirconium nitrate and zirconium sulfate solutions was determined by coagulation using negative silver bromide and silver iodide sols in statu nascendi. At pH <2.5, the prevailing species in dilute solutions of zirconium nitrate is Zr^{4+}. Over the pH range 5.5 to 7, a triply charged hydrolysis product is formed. Analysis of the coagulation data indicates the formation of either dimeric species, $Zr_2(OH)_2^{6+}$, or trimeric species, $Zr_3(OH)_5^{7+}$. At concentrations somewhat higher than those which cause coagulation, the zirconium solutions reverse the charge of the silver halides. This effect is also pH dependent. In solutions of zirconium sulfate, a slow hydrolysis from Zr^{4+} to triply charged species occurs which is followed by coagulation. This aging eventually culminates in a precipitation. (auth)

1447 THE EFFECT OF NITROUS OXIDE AND THE NATURE OF INTERMEDIATES IN THE PHOTOCHEMISTRY OF THE IODIDE ION IN AQUEOUS SOLUTION. Joshua Jortner, Michael Ottolenghi, and Gabriel Stein (Hebrew Univ., Jerusalem). J. Phys. Chem., 66: 2037-42(Oct. 1962).

The nature of the intermediates formed from the excited state of the I^- ions was considered. The scavenging mechanism by N_2O was investigated. Nitrous oxide was found to act as a specific scavenger for electrons. Semiquantitative treatment of the scavenging mechanisms is carried out. Chemical evidence for the transient formation of electrons in the photochemical system is presented. The mechanism of radical formation by the dissociation of the excited state is discussed. (auth)

1448 THE EFFECT OF OXYGEN ON THE PHOTOCHEMISTRY OF THE IODIDE ION IN AQUEOUS SOLUTIONS. Joshua Jortner, Michael Ottolenghi, and Gabriel Stein (Hebrew Univ., Jerusalem). J. Phys. Chem., 66: 2042-5(Oct. 1962).

The effect of O_2 on the photochemistry of aqueous iodide solutions was investigated. O_2 was found to act as a scavenger for both electrons and H atoms. The reaction mechanisms are discussed and kinetic data for the reaction of O_2 with electrons and H atoms are derived. The photochemical results are compared with data from radiation chemistry. (auth)

1449 ISOTOPE EXCHANGE REACTIONS IN THE $PtCl_4^{2-}$ + $PtCl_6^{2-}$ SYSTEMS. R. Dreyer (Zentralinstitut fur Kernphysik, Rossendorf, Ger.). Kernenergie, 5: 559-63 (July 1962).

The isotopic exchange reactions between $PtCl_4^{2-}$ and $PtCl_6^{2-}$ were measured under various conditions using Pt^{195}-labeled K_2PtCl_6 and Cl^{36}-labeled K_2PtCl_6. The half-value times of the exchange reactions is 0.5 up to 120 min according to the solvent (H_2O, 0.01 to 2.0 N HCl, 1.0 N H_2SO_4) and the temperature (22 to 90°C). Solutions were studied by paper ionophoresis after attainment of exchange equilibrium, and the reaction products present were identified as far as possible. Some measurements on the $PtCl_4^{2-}$ + $PtBr_6^{2-}$ system follow. (tr-auth)

1450 MEASUREMENT OF THE SIZE OF COLLOIDAL RADIOACTIVE GOLD PARTICLES BY MEANS OF CENTRIFUGATION. F. Girardi and R. Pietra (Centro Studi Nucleari, Ispra, Italy). Minerva Nucl., 5: 97-101(May 1961). (CNI-105). (In Italian)

A method for determining the particle size of colloidal radioactive gold is described. The method is based on centrifugal sedimentation of a sample from the radioactive colloid. The possibility of using the method for particle size analysis of colloidal chromic phosphate is briefly outlined. (auth)

1451 MOLECULAR PLATING: A METHOD FOR THE ELECTROLYTIC FORMATION OF THIN INORGANIC FILMS. W. Parker (Chalmers Univ. of Tech., Gothenburg, Sweden) and R. Falk. Nucl. Instr. Methods, 16: 355-7 (Aug. 1962). (In English)

A method was developed that may solve the problem of the preparations of thin films suitable for all the many different radioactive materials available for use in nuclear spectroscopy provided the thin film in question is not required as the metal. The most significant difference between the method and ordinary electrodeposition is that electrolytic dissociation does not occur to any comparable degree during the passage of current. Also, the same chemical compound, chloride or nitrate as the case may be, is deposited at the cathode as that originally dissolved in the electrolyte. Thus, the method is called molecular plating. Other differences are the use of high voltages (50-2000 v) and the use of an organic solution. The procedure and the advantages of the method are discussed. (P.C.H.)

1452 THERMODYNAMICS OF EXTRACTION OF NITRIC ACID BY TRI-n-BUTYL PHOSPHATE-HYDROCARBON DILUENT SOLUTIONS. I. DISTRIBUTION STUDIES WITH TBP IN AMSCO 125-82 AT INTERMEDIATE AND LOW ACIDITIES. Wallace Davis, Jr. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 14: 159-68(Oct. 1962). (ORNL-TM-43)

The distribution of 0 to 8 M HNO_3 between aqueous and 5 to 100 vol % solutions of TBP in Amsco 125-82 was measured and used to obtain a quantitative description of this extraction process. Up to ~5 M aqueous HNO_3, a limit arbitrarily chosen because of uncertainties in HNO_3 activity coefficients, the data at any particular concentration of

TBP in Amsco are accurately described by the equation $\log [(HNO_3)_{org}/\{[HNO_3]_{aq}(3.75493-(HNO_3)_{org})\}] = A + B(HNO_3)_{org}$, where parentheses refer to concentrations, square brackets to activities, and subscripts org and aq to organic and aqueous phases. The antilogarithms of the constants A for the six TBP-diluent solutions studied can be described as a linear function of $(Y^0_{H_2O} + Y^0_{TBP})$, the sum of the mole fractions, $Y^0_{H_2O}$ and Y^0_{TBP}, of water and TBP in the acid-free water-saturated organic phase. These antilogarithms were interpreted as the product $K_1^m\gamma_T$, where K_1^m is the thermodynamic equilibrium constant for the extraction reaction and γ_T is the mean activity coefficient of TBP and TBP · H_2O in the acid-free, water-saturated organic phase. As the concentration of TBP in Amsco 125-82 increases from 0 to 100%, $K_1^m\gamma_T$, in molal units, varies from 0.2 to 1.5. The quantities B of the above equation are proportional to $(Y^0_{TBP} + Y^0_{H_2O})^{1/3}$ while the product $B(HNO_3)_{org}$ is interpreted as $\log \gamma_{TN}$, where γ_{TN} is the mean activity coefficient of the species TBP · HNO_3 and TBP · HNO_3 · H_2O. The organic phase water and acidity values are consistent with formation of the complexes TBP · H_2O, TBP · HNO_3, TBP · HNO_3 · H_2O, and TBP · $2HNO_3$. (auth)

1453 THERMODYNAMICS OF EXTRACTION OF NITRIC ACID BY TRI-n-BUTYL PHOSPHATE-HYDROCARBON DILUENT SOLUTIONS. II. DENSITIES, MOLAR VOLUMES, AND WATER SOLUBILITIES OF TBP-AMSCO 125-82-HNO_3-H_2O SOLUTIONS. Wallace Davis, Jr. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 14: 169-73 (Oct. 1962). (ORNL-TM-116)

Densities and water contents of nearly dry and of water-saturated TBP-Amsco 125-82 solutions were measured. From these the molar volumes of TBP and this diluent were calculated to be 273.6 and 246.4 ml, respectively, in the pure dry state. Within experimental accuracy, the molar volume of water was 18 ml in all solutions. Using this value for water, the molar volume of nitric acid in TBP–Amsco 125-82–HNO_3–H_2O solutions was calculated, from data previously presented, to be between 40.9 and 43.7 ml, the specific value depending on the TBP/diluent ratio. Solutions of TBP and the diluent are nearly ideal with respect to additivity of volumes, the maximum deviation from ideality being ~0.4%, or ~1 ml per mole of solution based on a diluent gram molecular weight of 185. The water content of TBP saturated with water at 25°C corresponds to a mole ratio $Y^0_{H_2O}/Y^0_{TBP} = 1.045 \pm 0.001$. (auth)

1454 THERMODYNAMICS OF EXTRACTION OF NITRIC ACID BY TRI-n-BUTYL PHOSPHATE-HYDROCARBON DILUENT SOLUTIONS. III. COMPARISON OF LITERATURE DATA. Wallace Davis, Jr. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 14: 174-8(Oct. 1962). (ORNL-TM-155)

Some of the published data on the extraction of nitric acid from aqueous solutions, containing ≤ 5 M acid, by tributyl phosphate–hydrocarbon diluent solutions were tested for their agreement with a mathematical description presented in Part I. In all cases the agreement of the literature data with this description ranged from adequate to very good, thereby adding support to the interpretation of the parameters of the equation in terms of the equilibrium constant, K_1^c, for the extraction reaction and the two activity coefficients y'_T and y'_{TN}. The form of the mathematics suggests that TBP and TBP · H_2O are indistinguishable in their reaction with HNO_3 and that y'_T is an approximate mean molar activity coefficient of these two in the water-saturated system; similarly, y'_{TN} is an approximate mean molar activity coefficient of the two species TBP · HNO_3 and TBP · HNO_3 · H_2O. The quantity $K_1^c y'_T$ has a value of ~1.5 in molar units for diluent-free TBP; its extrapolated value in the pure diluent Amsco 125-82, or odorless kerosene, is ~0.23, while its value in n-hexane is ~0.27. (auth)

1455 THE REACTION OF PLUTONIUM OXIDE AND ALKALINE EARTH OXIDES. Cornelius Keller (Technische Hochschule, Karlsruhe, Ger. and Kernforschungszentrum, Karlsruhe, Ger.). Nukleonik, 4: 271-7(Oct. 1962). (In German)

In the thermal double decomposition of plutonium dioxide with alkaline earth oxide under oxidizing, neutral, and reducing conditions, reactions with barium, strontium, and calcium oxides could be ascertained. Magnesium and beryllium oxides did not react with plutonium oxides. The following oxides were prepared with hexavalent plutonium: Ba_3PuO_6 (a = 8.844A), Ba_2SrPuO_6 (a = 8.780A), $BaSr_2PuO_6$ (a = 8.717A), Sr_3PuO_6, as well as $Sr(PuO_2)O_2$ (a = 6.51A, α = 35°41′). The atomic distance Pu–O in $Sr(PuO_2)O_2$ amounted to: $Pu-20_I = 1.89A$ and $Pu-60_{II} = 2.28A$. In $Sr(PuO_2)O_2$ a linear $[O-Pu-O]^{2+}$ grouping exists. Calcium oxide reacts with plutonium oxide at 950 to 1050°C in an oxidizing atmosphere only partly for the formation of Ca_3PuO_6. By hydrolysis of Ba_3PuO_6 an oxide of the composition $BaPuO_4$ could be obtained. Under neutral conditions plutonium oxide reacted with barium and strontium oxides for formation of $BaPuO_3$ (a = 4.357A) and $SrPuO_3$ (a = 4.28A, pseudocubic). $BaPuO_3$ forms with Ba_3PuO_6 cubic mixed crystals with the composition Ba $(Pu^{IV}_x, Pu^{VI}_{½(1-x)}, Ba_{½(1-x)})O_3$. $BaPuO_3$ and $SrPuO_3$ are stable against thermal oxidation. Plutonium(III) oxide forms with barium oxide an oxide $BaO \cdot Pu_2O_3$ that is an isotope for corresponding ternary oxides of several rare earths. (tr-auth)

1456 FLUORINE COMPOUNDS OF XENON AND RADON. C. L. Chernick, H. H. Claassen, P. R. Fields, et al. (Argonne National Lab., Ill.). Science, 138: 136-8(Oct. 12, 1962).

Xenon and fluorine combine readily. Xenon tetrafluoride is a colorless crystalline material, stable at room temperature. The existence of at least one other fluoride and two oxyfluorides was demonstrated. The heaviest "inert gas," radon, also reacts with fluorine, yielding a compound less volatile than xenon tetrafluoride. (auth)

1457 THE FERROELECTRIC PROPERTIES OF TRIGLYCINE SULFATE CRYSTALS IRRADIATED WITH γ-QUANTA. V. A. Yurin, I. M. Sil'vestrova, and I. S. Zheludev (Inst. of Crystallography, Academy of Sciences, USSR). Soviet Phys.-Cryst. (English Transl.), 7: 312-18(Nov.-Dec. 1962).

The effects of γ radiation on the shape and parameters of the hysteresis loop and dielectric properties and the effect of static electric fields and temperature on the hysteresis loop of irradiated crystals of triglycine sulfate crystals were investigated. The results are compared with similar data for Rochelle Salt containing copper ions. (auth)

1458 AN X-RAY AND ELECTRICAL STUDY OF THE $PbTiO_3$–$LaAlO_3$ SYSTEM. S. A. Fedulov, Yu. N. Venevtsev, and D. F. Dzhmukhadze (Karpov Physicochemical Inst., USSR). Soviet Phys.-Cryst. (English Transl.), 7: 323-5 (Nov.-Dec. 1962).

Using x-ray methods, the existence of a continuous range of solid solutions in the $PbTiO_3$–$LaAlO_3$ system was established. Variation of the dielectric constant, electrical conductivity, and tangent of the angle of dielectric loss with temperature was investigated. From the results of the x-ray phase analysis and electrical measurements, the phase diagram of $PbTiO_3$–$LaAlO_3$ system was constructed. (auth)

1459 DOMAIN STRUCTURES OF MONOCRYSTALS OF THE FERRITES OF YTTRIUM, HOLMIUM, ERBIUM, AND GADOLINIUM. A. I. Drokin, V. D. Dylgerov, and B. V. Beznosikov (Inst. of Physics, Siberian Division Academy of Sciences, USSR). Soviet Phys.-Cryst. (English Transl.), 7: 371-4(Nov.-Dec. 1962).

The response of the domain structure to magnetic fields for the ferrites of Y, Ho, Er, and Gd as monocrystals is described. The domain structure on (110) for yttrium ferrite was the same as in isometric crystals. Figures on (211) were examined for the other ferrites. Erbium ferrite closely resembled holmium ferrite. The gadolinium ferrite showed features similar to those in magnesium-manganese ferrites. (P.C.H.)

1460 ON MAGNETIC PROPERTIES OF Eu FERRITE-GARNETS (FERRATES). V. I. Chechernikov. Vestn. Mosk. Univ., Ser. III, No. 3, 27-9(May-June 1962). (In Russian)

Investigations of a ferrite garnet of Eu near the Curie ferromagnetic point showed that the transition width for such ferromagnetics is about 8 to 10°. Diagrams of transition magnetization and α and β coefficients as function of temperature are constructed. (R.V.J.)

1461 INVESTIGATION OF ISOTOPIC EXCHANGE OF HYDROGEN BETWEEN WATER AND THIOLS. K. I. Sakodynskii, S. I. Babkov, and N. M. Zhavoronkov (Karpov Inst. of Physics and Chemistry, Moscow). Zh. Fiz. Khim., 36: 2169-75(Oct. 1962). (In Russian)

The partition coefficients for hydrogen isotopes between water and thiols of composition C_4—C_8 were determined at 20 to 80°. The kinetics of isotopic exchange between water and thiols was investigated in the presence of KOH, NaOH, H_2SO_4, and H_2S and in the absence of admixtures. It was shown that alkali and H_2S accelerate and H_2SO_4 retards the isotopic exchange. It was also found that γ radiation affects the rate of isotopic exchange without shifting the isotopic equilibrium. Comparisons of isotopic exchange and mutual solubility data showed that the isotopic exchange is limited by the aqueous phase resistance. With inert solvent the exchange is completed within seconds. Under counter-current conditions in a packed column the transport of deuterium takes place at a rate approaching that of ordinary diffusion processes in the system liquid—liquid. (auth)

1462 DETERMINATION OF THE SELF-DIFFUSION COEFFICIENT OF LITHIUM ION IN AQUEOUS LiCl SOLUTIONS. E. A. Bakulin and G. E. Zavodnaya (Ioffe Inst. of Physics and Tech., Academy of Sciences, USSR). Zh. Fiz. Khim., 36: 2261-3(Oct. 1962). (In Russian)

The coefficient of Li ion diffusion in LiCl solutions at 1.94 up to 11.56 g-equiv/1000 g H_2O was measured by a free diffusion method. (R.V.J.)

1463 EXCHANGE REACTION BETWEEN ETHYLENE AND DEUTEROETHYLENE ON AN ALUMOSILICATE CRACKING CATALYST. S. V. Markevich (Inst. of Physics and Organic Physics, Academy of Sciences, Belorussian SSR). Zh. Fiz. Khim., 36: 2307-8(Oct. 1962). (In Russian)

The mechanism of D_2 reaction with C_2H_4 was analyzed previously and the accumulation sequence for deuteriumethylene was presented as $C_2H_3D > C_2H_2D_2 > CHD_3 > C_2D_4$. These results were verified by a dissociative exchange mechanism supported by free hydrogen atoms in the ethylene. A supplementary study was made of C_2H_4 and C_2D_4 exchange reaction under the conditions used for C_2H_4 and D_2 reaction. (R.V.J.)

1464 PROPERTIES OF LANTHANUM AND NEODYMIUM HYDRIDES. V. I. Mikheeva and M. E. Kost. Zh. Neorgan. Khim., 7: 1493-9(July 1962). (In Russian)

Hydridation of La with mixed metal (50% Ce, 45% various rare earths, and 2% Fe) resulted in a product resembling a trihydride, while Nd hydridation formed $NdH_{2.4}$. Contrary to published data, Nd exhibited the ability to combine with H at room temperature. It was shown that mixed metal easily combines with hydrogen while Nd reacts with hydrogen slowly and incompletely. The absorption isobar, the absorption rate, and thermographic studies show the existence of di- and trihydrides. Reactions of hydrides with water exhibited higher activity for La hydride than for Nd hydride and mixed metal hydride. The density of Nd hydride was correlated with the densities of other rare-earth hydrides. (R.V.J.)

1465 PREPARATION AND PROPERTIES OF CERTAIN URANYL FLUORIDE COMPLEXES. L. L. Zaitseva, L. V. Lipis, V. V. Fomin, and N. T. Chebotarev. Zh. Neorgan. Khim., 7: 1538-47(July 1962). (In Russian)

Absorption spectra and x-ray diffraction analyses of precipitates produced by mixing 6.08 mole of CsF solution with 0.63 mole of UO_2F_2 at Cs^+/UO_2^{2+} ratios from 0.5 to 20 showed that $CsUO_2F_3$ was formed at ratios from 0.5 to 1.5, to $Cs_2UO_2F_4 \cdot H_2O$ at ratios of 2 to 3, and $Cs_3UO_2F_5$ at ratios of 6 to 20. It was also found that concentrations of 1 : 2 of UO_2F_2 (0.63 mole) and CsF(6.08 mole) formed $Cs_2UO_2F_4 \cdot H_2O$ by evaporation in vacuum and $CsUO_2F_3 \cdot H_2O$ by slow evaporation in air. The $CsUO_2F_3$ is easily precipitated from concentrated solutions, while diluted solutions of UO_2F_2 and CsF slowly precipitate into $CsUO_2F_3$ and $CsUO_2F_3 \cdot H_2O$. (R.V.J.)

1466 CESIUM OCTARHODANOTHORATE $Cs_4[Th(CNS)_8] \cdot 2H_2O$. A. K. Molodkin and G. A. Skotnikova. Zh. Neorgan. Khim., 7: 1548-51(July 1962). (In Russian)

Preparation of highly coordinated thorium compounds with admixtures combining with the central atom without the aid of oxygen was studied. Synthesized $Cs_4[Th(CNS)_8] \cdot 2H_2O$ was studied, and preparation of a genetic series of Th aquarodanide complexes in aqueous solution is discussed. (R.V.J.)

1467 SYNTHESIS OF SOME ZIRCONYL OXALATE COMPOUNDS. L. M. Zaitsev and G. S. Bochkarev. Zh. Neorgan. Khim., 7: 1552-8(July 1962). (In Russian)

Preparations of $H_2[ZrO(C_2O_4)_2] \cdot 3H_2O$ and ammonium and barium salts of zirconyl oxalate hydroxalic acid are described. A method is given for zirconyl oxalate synthesis from methanol solutions. Molar electric conductivity and thermogravimetric methods were used for confirming the individuality of synthesized dizirconyl oxalatochloride and the products of its thermal decomposition. (R.V.J.)

1468 STUDIES OF LANTHANUM COMPLEXING WITH GLUCONIC ACID BY ION EXCHANGE. N. A. Kastromina. Zh. Neorgan. Khim., 7: 1559-64(July 1962). (In Russian)

Complexing in the lanthanum chloride–gluconic acid system at acid pH ~ 3 was studied by ion exchange. Cationic, neutral, and anionic complexes containing from one to six monovalent gluconic acid radicals were formed in the system. The instability constants were determined for LaA_n (where n is 1 to 6). (R.V.J.)

1469 STUDIES OF PHOSPHORONIOBIOMOLYBDENUM COMPLEX. A. K. Babko and Yu. F. Shkalovskii (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Zh. Neorgan. Khim., 7: 1565-9 (July 1962). (In Russian)

Equilibrium and structure of phosphoroniobomolybdenum complexes were studied with respect to pH and light absorption at 413 mμ. It is shown that the compound is stable and has a wider range of acidity than phosphoromolybdenum compounds. The phosporomolybdenum compound was separated from phosphoroniobiomolybdenum by butylacetate. The ratio of Nb : P = 2 : 1 at pH2 and the Mo : P ratio is 11. (R.V.J.)

1470 KINETIC STUDIES OF THORIUM OXALATE COMPLEXES. K. B. Yatsimirskii and Yu. A. Zhukov. Zh. Neorgan. Khim., 7: 1583-8(July 1962). (In Russian)

Reactions of thorium nitrate with oxalic acid at 10^{-5} mole/l form $Th_2C_2O_4OH^{5+}$ and $ThC_2O_4^{2+}$ complexes. Stability constants for $ThC_2O_4^{2+}$ and $Th_2C_2O_4OH^{5+}$ were determined. (R.V.J.)

1471 SOLID SOLUTIONS OF RARE EARTH ORTHO SILICATES AND STRONTIUM ORTHOSILICATES. N. A. Toropov and Chih-chun Mao. Zh. Neorgan. Khim., 7: 1632-5(July 1962). (In Russian)

Limited-solubility solid solutions were formed in $Sr(SiO_4) - La_4(SiO_4)_3$, $Sr_2(SiO_4) - Nd_4(SiO_4)_3$, and $Sr_2(SiO_4) - Y_4(SiO_4)_3$. Homogeneous regions were found in strontium orthosilicates with 100 to 85 wt % $La_4(SiO_4)_3$, 100 to 85 wt % $Nd_4(SiO_4)_3$, and 100 to 80 wt % $Y_4(SiO_4)_3$. In solid solutions with higher contents of La, Nd, and Y orthosilicate the refractive indices increase and the melting temperatures drop. (R.V.J.)

1472 REACTIONS OF UCl_4 AND $U(SO_4)_2$ WITH NaF IN AQUEOUS SOLUTIONS. I. V. Tananaev, N. P. Galkin, G. S. Savchenko, and V. M. Sutyagin. Zh. Neorgan. Khim., 7: 1675-80(July 1962). (In Russian)

Solubility in $UCl_4 - NaF - H_2O$ and $U(SO_4)_2 - NaF - H_2O$ systems was analyzed. The study revealed gradual stepwise reactions of UCl_4 and $U(SO_4)_2$ with sodium fluoride. A UF_5^{2+} ion formed at NaF/UCl_4 ratios from 0.5 to 2.0, UF_4 appeared at ratios of 2.0 to 4.0, and $NaUF_5 \cdot H_2O$ was observed at ratios of 5.0 to 10.0. The binary salt dissolves incongruently into $UF_4 \cdot 2.5H_2O$ and NaF. (R.V.J.)

1473 REACTIONS IN $Hf-ZrF_4-H_2O$ AT 25°. N. S. Nikolaev, Yu. A. Buslaev, and M. P. Gustyakova. Zh. Neorgan. Khim., 7: 1685-92(July 1962). (In Russian)

Solubility in $Hf-ZrF_4-H_2O$ systems in 0 to 70.49% hydrofluoric acid solutions was studied at 25°C. Solid solutions of $Zr_4O_3F_{10} \cdot 6H_2O$, $ZrF_4 \cdot 3H_2O$, $HZrF_5 \cdot 4H_2O$, and $H_2ZrF_6 \cdot 2H_2O$ were found. Thermographic, thermogravimetric, and x-ray diffraction analyses were made of the pentafluorozirconium, and the properties of other fluorozirconium acids were studied by ion exchange, cryoscopy and electric conductivity. It is shown that pentafluorozirconium is a strong acid, but at certain concentrations it decomposes into $H^+ + ZrF_5^- \rightarrow HF + ZrF_4$. Hexafluorozirconium decomposition is expressed by the formula $2H^+ + ZrF_6^{2-} \rightleftharpoons HF + H^+ + ZrF_5^-$. (R.V.J.)

1474 SOLUBILITY ISOTHERM OF QUATERNARY INTERSYSTEMS $Th(C_2O_4)_2 + 2Na_2CO_3 \rightleftharpoons Th(CO_3)_2 + 2Na_2C_2O_4 - H_2O$ AT 25°. I. S. Kovaleva and N. P. Luzhnaya. Zh. Neorgan. Khim., 7: 1693-8(July 1962). (In Russian)

An analysis was made of the ternary system $Na_2CO_3 - Na_2C_2O_4 - H_2O$. The solubility of the aqueous intersystem with thorium and sodium oxalates and carbonates was investigated at 25°C. Crystallization limits of $Na_2CO_3 \cdot 10H_2O$, $Na_2C_2O_4$, and $Na_4Th(C_2O_4)_4 \cdot 6H_2O$ were found, and the crystallization fields of $Th(C_2O_4)_2 \cdot 6H_2O$ and $Na_6Th(CO_3)_5 \cdot 12H_2O$ were partially outlined. An "X" region was also observed but the composition of the phase was not determined due to strong hydrolysis. (R.V.J.)

1475 SYNTHESIS OF THORIOMOLYBDENUM HETEROPOLY ACID. Z. F. Shakhova, S. A. Gavrilova, and V. F. Zakharova. Zh. Neorgan. Khim., 7: 1752-3(July 1962). (In Russian)

Preparation of thoriomolybdenum heteropoly acid by ion exchange is described, and thoriomolybdenum heteropoly acid ammonium salts were analyzed for Th and Mo. (R.V.J.)

1476 PREPARATION OF HfC BY HfO_2 REDUCTION BY HYDROGEN. V. I. Zhelankin, V. S. Kutsev, and B. F. Ormont. Zh. Neorgan. Khim., 7: 1762-4(Aug. 1962). (In Russian)

A manometric analysis was made of the equilibrium in Hf-C-O at 1700 to 2600°K and 20 to 1000 mm Hg pressure in order to determine the conditions of HfC formation. At 2100 to 2600°K and 20 to 700 mm Hg the C content of HfC is near to stoichiometric HfC. An oxide-free carbide is formed at 2200°K even with CO pressure at 20 to 700 mm. Increases in CO pressure and temperature (up to 2300°K) do not affect HfC composition. (R.V.J.)

1477 PHOTOCOLORIMETRIC DETERMINATION OF THE pH OF THE INITIAL $Hf(OH)_4$ SOLUBILITY. P. N. Kovalenko and K. N. Bagdasarov. Zh. Neorgan. Khim., 7: 1765-8(Aug. 1962). (In Russian)

Data from Hf reaction with the organic reagent, stilbazo, were used in the photocolorimetric analysis of the pH for initial $Hf(OH)_4$ solubility at 20°C. The resulting activity of hafnium hydroxide was calculated to be 3.7×10^{-55}. (R.V.J.)

1478 PHOTOCOLORIMETRIC DETERMINATION OF THE INITIAL pH OF SOLUBILITY AND ACTIVITY. P. N. Kovalenko and K. N. Bogdasov. Zh. Neorgan. Khim., 7: 1769-72(Aug. 1962). (In Russian)

Photocolorimetric analysis was made of pH in the initial solubility of $Sm(OH)_3$. The activity of $Sm(OH)_3$ at 20°C was determined, and effects of admixtures on the initial solubility were studied. (R.V.J.)

1479 CATALYTIC OXIDATION OF POTASSIUM IODIDE BY HYDROGEN PEROXIDE IN PRESENCE OF Hf SALTS. K. B. Yatsimirskii and L. P. Raizman. Zh. Neorgan. Khim., 7: 1819-23(Aug. 1962). (In Russian)

Kinetics of potassium iodide oxidation by hydrogen peroxide in acid solutions in the presence of hafnium salts was studied. It was found that the rate of reaction linearly depends on the concentration of Hf and potassium iodides and is not affected by H_2O_2. Small concentrations of Hf were determined in pure Hf salt solutions. It was also found that Hf ions form strong complex compounds with tartaric, oxalic, and acetic acids as well as with phosphate, fluoride, and sulfide ions. (R.V.J.)

1480 INVESTIGATIONS OF URANYL PHOSPHATE PHYSICO-CHEMICAL PROPERTIES. V. I. Karpov and Ts. L. Ambartsumyan. Zh. Neorgan. Khim., 7: 1838-41 (Aug. 1962). (In Russian)

Thermographic, thermogravimetric, and luminescence methods were used in an investigation of physical and chemical properties of uranyl phosphates. Analyses were made of the physico-chemical properties of natural and prepared uranyl phosphate specimens. (R.V.J.)

1481 URANYL PHOSPHATE PRECIPITATION PROCESS. V. I. Karpov and V. G. Bakhurov. Zh. Neorgan. Khim., 7: 1842-5(Aug. 1962). (In Russian)

Studies were made of chemical affinity in precipitation and the mutual bonding of uranyl phosphate in ionic solutions. It was revealed that the formation of neutral phosphates and $(NH_4)_2(UO_2)_3(PO_4)_4 \cdot 6H_2O$ is related to the presence of hydrolyzed uranyl ions. Comparisons were made of

the properties of natural and prepared uranyl phosphates. (R.V.J.)

1482 ON RHODONINE ZIRCONIUM COMPOUNDS. I. V. Tananaev and I. A. Rozanov. Zh. Neorgan. Khim., 7: 1854-9(Aug. 1962). (In Russian)

Preparation and properties of $MeNCS \cdot ZrO(NCS)_2 \cdot 2H_2O$ (where Me = NH_4, K, Rb, Cs, and PyH) are studied. The formula for the examined complexes is expressed by $Me[ZrO(NCS)_3H_2O]H_2O$. Hydrogen ion concentration to 2.4 mole/l results in a rhodonide complex with Zr^{4+} and composition $(PyH)_2[Zr(NCS)_6] \cdot nH_2O$. (R.V.J.)

1483 PRECIPITATION OF ZIRCONIUM PEROXIDE COMPOUNDS FROM SULFURIC SOLUTIONS. V. I. Tikhomirov, B. V. Levin, V. V. Mironova, and V. M. Solovaya (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Neorgan. Khim., 7: 1860-8 (Aug. 1962). (In Russian)

Precipitations of zirconium peroxide compounds from sulfate solutions at pH 0.1 to 2.7 were studied. Zirconium peroxysulfates ($Zr_2O_6SO_4 \cdot 8$ to 10 H_2O) were formed at pH 0.1 to 0.7. Zirconyl peroxysulfates were separated at pH 0.8 to 2.7, and formulas were developed for di- and tri-nuclear complexes: $(ZrO)_2(OO)SO_4 \cdot nH_2O$ and $(ZrO)_3(OO)_2SO_4 \cdot nH_2O$. The chemical and physicochemical properties of zirconium peroxides and zirconyl peroxides were studied. (R.V.J.)

1484 PHENANTHROLINE COMPLEXES OF RARE EARTHS IN SOLUTIONS. L. I. Konenko and N. S. Poluektov. Zh. Neorgan. Khim., 7: 1869-73(Aug. 1962). (In Russian)

Rare earth absorption spectra revealed complex cations formed by rare earth ions with phenanthroline in aqueous solution. Two phenanthroline molecules were found per one atom of holmium. Silicides of phenanthroline complex cations are extracted by benzene at 4 to 6 pH. Neodymium complexes are extracted as neodymium diphenanthrolinetrisilicide. (R.V.J.)

1485 THERMOGRAPHIC STUDIES OF DECOMPOSITIONS OF CERIUM. M. N. Ambrozhii and E. F. Luchnikova. Zh. Neorgan. Khim., 7: 1874-9(Aug. 1962). (In Russian)

Thermal analyses were made of decomposition processes in simple La, Ce, Pr, Nd, and Sm citrates, and data on phase studies are given. The first stage of citrate decomposition was expressed by elimination of crystal water; the second by the presence of carbon oxide in the dissociation products; in the third stage citrates converted into dioxides immediately after the dissociation into sesquioxides. The dioxides produced no catalytic effects on carbon oxide and the CO_2 was oxidized by air to carbon anhydride. (R.V.J.)

1486 NEODYMIUM CHLORIDE REACTIONS WITH GLYCINE. O. E. Zvyagintsev and E. V. Goncharov. Zh. Neorgan. Khim., 7: 1880-91(Aug. 1962). (In Russian)

Neodymium chloride and glycine reactions in solution were studied by measuring pH, specific conductance, and optical density at various stages of glycine neutralization by alkali. Maximum reaction was observed with neutralization of half the equivalent hydrogen ions, producing a complex of $Gl^- : Nd^{3+} = 1:1$ and a neutral complex of 3:1. Further neutralization to the total equivalent of hydrogen ions eliminates the 3:1 complex and replaces it with $Gl^- : Nd^{3+} = 2:1$ with an OH group. It is postulated that neodymium hydroxyglycinate is formed at ph $\simeq$ 8.0 to 9.0. Crystalline compounds of $NdCl_3 \cdot 3NH_2CH_2COOH \cdot 3H_2O$, $[Nd(NH_2CH_2COO)(H_2O)_4]Cl_2 \cdot H_2O$, and $[Nd(NH_2CH_2COO)_3]3H_2O$ were prepared and their structures studied. (R.V.J.)

1487 REACTIONS OF NEODYMIUM CHLORIDE WITH α ALANINE. O. E. Zvyagintsev and E. V. Goncharov. Zh. Neorgan. Khim., 7: 1892-1901(Aug. 1962). (In Russian)

Reactions of $NdCl_3$ with α-alanine in aqueous solutions were studied in order to determine the tendencies to complexing during neutralization. Complex ions with stoichiometric 1:1 and 2:1 coefficients and a neutral complex of 3:1 were found, and the feasibility of forming neodymium hydroxyalaninates at pH < 8.0 was postulated. The compounds $NdCl_3 \cdot AnH \cdot 4H_2O$, $NdCl_3 \cdot 3AnH \cdot 3H_2O$, $[Nd(An)]Cl_2 \cdot 4H_2O$, and $[Nd(An)_3] \cdot 2H_2O$ were analyzed. Complexes of α-alanine with $NdCl_3$ are less stable than corresponding glycine complexes. Thermal properties of crystalline compounds indicate higher stability in comparison to corresponding glycine complexes except for $NdCl_3 \cdot 3GlH \cdot 3H_2O$ and $NdCl \cdot 3AnH \cdot 3H_2O$. (R.V.J.)

1488 MELT DIAGRAMS OF CADMIUM AND POTASSIUM BROMIDE AND CHLORIDE SYSTEMS. I. I. Il'yasova and A. G. Bergman. Zh. Neorgan. Khim., 7: 1970-3(Aug. 1962). (In Russian)

Complex formations in Na, K, Cd, and Pb chlorides, bromides, and iodides were studied and melt diagrams for $CdCl_2-K_2Br_2$, $CdBr_2-K_2Cl_2$, and ternary systems of K, Cd/Cl, Br were constructed. The binary Na and Pb salts form only eutectic mixtures. In addition to eutectic mixtures, NaBr and $CdBr_2$ with chlorides and iodides form incongruent systems of $CdI_2 \cdot 2NaI(CdCl_2 \cdot 2NaCl$, P = 433° and $CdI_2 \cdot 2NaI$, P = 355°). Compounds of potassium and cadmium chlorides form one congruent system, $CdCl_2 \cdot KCl$(428°), and one incongruent system, $CdCl_2 \cdot 4KCl$(462°). (R.V.J.)

1489 THERMAL ANALYSIS OF $NbCl_4-NaCl-KCl$ SYSTEMS. B. G. Korshunov and V. V. Safronov (Moscow Inst. of Fine Chemical Tech.). Zh. Neorgan. Khim., 7: 1974-8(Aug. 1962). (In Russian)

Reactions of $NbCl_4$ with NaCl and KCl in melts were studied and a melt diagram of $NbCl_4-NaCl-KCl$ was constructed. Crystallization phase boundaries and four-phase equilibrium points were found. (R.V.J.)

1490 REACTIONS OF Nb(IV) WITH RUBIDIUM AND CESIUM CHLORIDES. V. V. Safonov, B. G. Korshunov, and Z. N. Shevtsova (Moscow Inst. of Fine Chemical Tech.). Zh. Neorgan. Khim., 7: 1979-82(Aug. 1962). (In Russian)

An analysis was made of $NbCl_4$ reactions with RbCl and CsCl in melts, and melt diagrams of $NbCl_4-RbCl$ and $NbCl_4-CsCl$ were constructed. Calculations using the Schrader equation postulate the presence of complex $(NbCl_6)^{2-}$ ions in the $NbCl_4-Rb$ system, and two different complex ions, $(NbCl_5)^-$ and $(NbCl_6)^{2-}$, in $NbCl_4-CsCl$. (R.V.J.)

1491 SOLUBILITY IN $In_2(SO_4)_3-K_2SO_4-H_2O$ AT 20°. E. N. Deichman and G. V. Rodicheva (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Neorgan. Khim., 7: 1994-7(Aug. 1962). (In Russian)

Solubilities in $In_2(SO_4)_3-K_2SO_4-H_2O$ at 20°C were analyzed, and it is shown that, depending on the concentration of potassium sulfate, two compounds are formed in the system: $KIn(SO_4)_2 \cdot 2H_2O$ and $K_2In(OH)(SO_4)_2 \cdot nH_2O$. The properties of both compounds are investigated. A thermographic analysis indicated that dehydration produces anhydrous $KIn(SO_4)_2$. The disintegration of potassium sulfate begins at 780°C. It is postulated that two water molecules are incorporated during the formation of complex indium sulfates with potassium, rubidium, and cesium. (R.V.J.)

1492 LUTETIUM CHLORIDES AND HYDROXIDES. N. V. Aksel'rud and T. I. Akhrameeva (Inst. of General and Inorganic Chemistry, Academy of Sciences, Ukrainian SSR). Zh. Neorgan. Khim., 7: 1998-2001(Aug. 1962). (In Russian)

Solubilities and properties of basic Lu chlorides and oxides were studied by measuring three variables. The isobar-isothermal potentials of difficultly soluble compounds formed by adding caustic soda to lutetium chloride in the presence of sodium chloride at 25°C were measured. In freshly prepared systems the formula $Lu(OH)_2Cl$ describes the equilibrium, and after 50 days the formula changes to $Lu(OH)_{2.5}Cl_{0.5}$. Later the system converts into lutetium hydroxide. (R.V.J.)

1493 PHYSICO-CHEMICAL PROPERTIES OF AMMONIUM URANYLPENTAFLUORIDE. N. P. Galkin, U. D. Veryatin, and V. I. Karpov. Zh. Neorgan. Khim., 7: 2020-2(Aug. 1962). (In Russian)

Thermographic, thermogravimetric, and x-ray diffraction methods were used in an investigation of ammonium uranylpentafluoride physico-chemical properties. Thermal disintegration in air was analyzed on the basis of derived data. The appearance of $NH_4UO_2F_3$ was observed at one stage of the thermal disintegration. (R.V.J.)

1494 THERMAL DECOMPOSITION OF Y, Sc, AND La OXALATES. Ya. S. Savits-Kaya, N. N. Tvorogov, S. V. Kalabukhova, and L. S. Brykina. Zh. Neorgan. Khim., 7: 2029-33(Sept. 1962). (In Russian)

Thermographic and thermogravimetric characteristics are given for scandium, yttrium, and lanthanum oxalate decomposition in air. The decomposition culminates by forming corresponding oxides, evolving CO and CO_2. (R.V.J.)

1495 PREPARATION OF PROPERTIES OF COMPLEX U(IV) NITRATES. A. D. Gel'man, N. N. Krot, and N. P. Eromolaev (Inst. of Physical Chemistry, Academy of Sciences, USSR). Zh. Neorgan. Khim., 7: 2034-44 (Sept. 1962). (In Russian)

Descriptions are given of preparations of complex solid-state U(IV) nitrates. Pure $Cs_2U(NO_3)_6$, $(C_5H_5NH)_2\ U(NO_3)_6$, $(H_2NC_5H_4NH)_2\ U(NO_3)_6$, $K_3H_3U(NO_3)_{10} \cdot 3H_2O$, $(NH_4)_2\ U(NO_3)_6$, $Rb_2U(NO_3)_6$, $(C_9H_7NH)_2\ U(NO_3)_6$, $MgU(NO_3)_6 \cdot 8H_2O$, $ZnU(NO_3)_6 \cdot 8H_2O$, and $C_{10}H_8(NH)_2\ U(NO_3)_6 \cdot 2.5H_2O$ were prepared and analyzed. Properties of the prepared compounds and their thermal decomposition products are studied. (R.V.J.)

1496 UREA AND ACETAMIDE URANYL COMPOUNDS. V. P. Markov and I. V. Tsapkina. Zh. Neorgan. Khim., 7: 2045-53(Sept. 1962). (In Russian)

Neutral oxygen-containing molecules of urea and acetamide were synthesized with uranyl nitrates, chlorides, sulfates, and oxalates. It was found that a maximum number of neutral molecules joining a given salt depends on the anion of the salt. It was also found that the maximum acetamide molecules joining with uranyl were always smaller than that for urea molecules. (R.V.J.)

1497 BEHAVIOR OF ETHYLENEDIAMINETETRAACETIC ACID IN ACID SOLUTIONS AND REACTION WITH U(IV). N. N. Krot, N. P. Ermolaev, and A. D. Gel'man (Inst. of Physical Chemistry, Academy of Sciences, USSR). Zh. Neorgan. Khim., 7: 2054-60(Sept. 1962). (In Russian)

Spectrophotometric studies were made of U(IV) complexing with EDTA in acid medium. It is shown that hydrogen ions join EDTA molecules by a step-line process forming H_5Y^+ and H_6Y^{2+} ions. Dissociation constants for H_5Y^+ and H_6Y^{2+} were calculated, and the instability constant for UY complex was found. The obtained data were used for verifying the Pu(IV)–EDTA complex instability constants. (R.V.J.)

1498 CESIUM PROPIONATE, BUTYRATE AND ISOVALERATE. V. E. Plyushchev, M. V. Savel'ev, and I. V. Shakhno. Zh. Neorgan. Khim., 7: 2078-81(Sept. 1962). (In Russian)

Synthesis of hydrous cesium propionate, butyrate and isovalerate is described, and the refractive indexes and densities of prepared salts are measured. Solubilities of the salts in ethyl, propyl, and butyl alcohols and of cesium propionate in water were analyzed at 25°C. The thermal stability and melting and boiling points were determined. (R.V.J.)

1499 METASTABLE MODIFICATION OF Li_2ZrO_3 and Li_2HfO_3. V. E. Plyushchev and A. A. Grizik (Moscow Inst. of Fine Chemical Tech.). Zh. Neorgan. Khim., 7: 2086-94 (Sept. 1962). (In Russian)

Various composition lithium zirconates and hafnates prepared with $ZrO_2(HfO_2)$ and Li_2CO_3 and LiOH are analyzed. A metastable lithium metazirconate modification (Li_2ZrO_3) was developed, and it is shown that the compound previously prepared with Li_2O was erroneously considered to be lithium orthozirconate (Li_4ZrO_4). A metastable modification of Li_2HfO_3 was synthesized and its properties studied. (R.V.J.)

1500 POTASSIUM ZIRCONATE. A. A. Grizik and V. E. Plyushchev. Zh. Neorgan. Khim., 7: 2095-2102(Sept. 1962). (In Russian)

Zirconium dioxide reactions with various potassium compounds (carbonate, hydroxide, and nitrate) were studied at 400 to 1200°C, considering the initial composition and the duration of the process. Chemical and x-ray phase analyses showed two different compounds in the K_2O-ZrO_2 system; one of the compounds was identified as potassium trizirconate $K_2O \cdot 3ZrO_2$. Thermal stability and hydrolysis of potassium trizirconate and its reactions with various reagents are studied, and density and refraction for pure $K_2O \cdot 3ZrO_2$ are determined. (R.V.J.)

1501 HYDROLYSIS AND POLYMERIZATION OF Hf IONS IN HYDROCHLORIC ACID. V. M. Peshkova and P'eng Ang. Zh. Neorgan. Khim., 7: 2110-14(Sept. 1962). (In Russian)

Hydrolysis constants for Hf ions were determined to be: $K_1 = 1.33 \pm 0.02$, $K_2 = 0.59 \pm 0.01$, $K_3 = 0.38 \pm 0.02$, and $K_4 = 0.30 \pm 0.03$. Hafnium ion concentrations forming polymers in 1 molar $HClO_4$ were $\Sigma(Hf) = 1.0 \times 10^{-3}$ mole; in 2 molar $HClO_4$, $\Sigma(Hf) = 2.0 \times 10^{-3}$ mole. A monomer, trimer, and tetramer are formed in 1 and 2 molar $HClO_4$. The equilibrium constants were calculated for $[Hf_3(OH)_4]^{8-}$ and $[Hf_4(OH_8)]^{8-}$ in 1 molar $HClO_4$ ($K_{3,4} = 2.34 \times 10^4$ and $K_{4,8} = 1.01 \times 10^8$) and in 2 molar $HClO_4$ ($K_{3,4} = 4.20 \times 10^4$ and $K_{4,8} = 4.32 \times 10^8$). (R.V.J.)

1502 STABILITY OF Tl AND In MIXED HALIDES. Ya. D. Fridman, R. I. Sorochan, and N. V. Dolgoshova. Zh. Neorgan. Khim., 7: 2127-33(Sept. 1962). (In Russian)

Solubilities of thallium iodide and thallium bromide in iodide-bromide and bromide-chloride solutions were determined at 25°C. Concentrations and stabilities of $TlIBr^-$, TlI_2Br^{2-}, $TlBrCl^-$, and $TlBr^2Cl^{2-}$ were determined, and it is shown that bromoiodide complexes are more stable than chlorobromide. Polarographic and potentiometric analyses were made of indium chloride-bromide and bromide-iodide solutions at 25°C and ionic strength ($\mu = 4$). Constants of formation were determined for $InCl^{2+}$, $InCl_2^+$, $InCl_3$, $InBr^{2+}$, $InBr_2^+$, $InClBr^+$, $InCl_2Br$, and $InCl_3Br^-$. Mixed

In halide compounds are less stable than similar Tl compounds. (R.V.J.)

1503 THERMOGRAPHIC STUDIES OF $NbOCl_3$–NaCl AND $NbOCl_3$–KCl SYSTEMS. S. A. Shchukarev, E. K. Smirnova, and T. S. Shemyakina. Zh. Neorgan. Khim., 7: 2217-19(Sept. 1962). (In Russian)

Thermographic studies of $NbOCl_3$–KCl revealed two compounds: $KNbOCl_5$ congruently melting at 440°C and K_2NbOCl_5 incongruently melting at 486°C. The system exhibits a stratification region with monotectic transformation temperature of 546°, while eutectic lines are found between 388° and 422°. A thermographic analysis of $NbOCl_3$–NaCl showed that $NaNbOCl_4$ does not melt congruently at 430°C. The system exhibits a stratified region, monotectic transformation at 760°C, and eutectic lines at 380 and 410°C. (R.V.J.)

1504 ELECTROCONDUCTIVITY OF BINARY OXIDES WITH Nb_2O_5. A. I. Manakov, O. A. Esin, and B. M. Lepinskikh (Ural Department of the Academy of Sciences, USSR). Zh. Neorgan. Khim., 7: 2220-5(Sept. 1962). (In Russian)

Electric conductivity of K_2O–Nb_2O_5, Li_2O–Nb_2O_5, CaO–Nb_2O_5, Al_2O_3–Nb_2O_5, Fe_2O_3–Nb_2O_5 and V_2O_5–Nb_2O_5 systems at 0 to 50 mole % and 700 to 1600°C was studied. Electric conductivity polytherms of liquidus and solidus phases were evaluated and constitution diagrams were constructed. All compositions of Fe_2O_3–Nb_2O_5 and U_2O_5–Nb_2O_5 retain their conductivity, while in the other compounds, with increased Me_aO_b the conductivity becomes ionic. (R.V.J.)

1505 REACTIONS OF LiCl–NaCl AND LiBr–NaBr IN MELTS. A. S. Arabadzhan and A. G. Bergman (Rostov-on-Don Scientific-Research Inst. of Machine Building Tech., USSR). Zh. Neorgan. Khim., 7: 2226-9(Sept. 1962). (In Russian)

A phase diagram constructed for Li, Na, K||Cl showed two incongruently melting compounds, LiCl · NaCl and LiCl · 2NaCl. One triple-eutectic and two triple-transition points were found within the system. A melt diagram for LiBr–NaBr was also constructed, and two compounds, LiBr · NaBr and LiBr · 2NaBr, were found. The results refute data on the isomorphism of Li and Na halides. (R.V.J.)

1506 INVESTIGATIONS ON TERNARY LiCl–KCl–NaCl SYSTEM. G. A. Bukhalova and A. S. Arabadzhan (Rostov-on-Don Scientific-Research Inst. of Machine Building Tech., USSR). Zh. Neorgan. Khim., 7: 2230-2 (Sept. 1962). (In Russian)

A phase diagram of Li_2Cl_2–Na_2Cl_2–CaCl was constructed, and two incongruently melting complexes were found. (R.V.J.)

1507 DER NIEDERDRUCK-ISOTOPENAUSTAUSCH ZWISCHEN WASSERSTOFF UND WASSRIGEN SUSPENSIONEN VON PLATIN- UND PALLADIUMKATALYSATOREN. (Low Pressure Isotope Exchange Between Hydrogen and Aqueous Suspensions of Platinum and Palladium Catalysts). Mohyi-Eldin Kenawy. Thesis, Karlsruhe, Ger., Technische Hochschule, 1961. 26p.

The catalytic action of platinum and palladium suspensions on H_2 and D_2 exchange is studied at low pressure. The concentration of the intermediary product HD in the gas phase is measured with a mass spectrometer. The influence of experimental conditions such as D pressure, additional electrolytes, and temperature is determined. For palladium catalysts the reaction rate is proportional to the square root of the pressure, whereas for platinum the increase is much more rapid. Measurements of the activation energy of the D_2 exchange velocity gave values of 7.4 and 3.4 kcal/mole for palladium and platinum respectively. (Gmelin)

1508 FREE RADICALS AS STUDIED BY ELECTRON SPIN RESONANCE. D. J. E. Ingram. New York, Academic Press Inc., 1958. 281p.

Discussion is given on widely different branches of research: electronics and physics for basic techniques and design data; physical, organic, and biochemistry for actual compounds studied; and biological and medical fields for several of the most interesting applications. An approach via the experimental side was adopted, and the various methods of free radical investigations are first outlined. General design considerations of electron resonance spectrometers and the experimental techniques used are considered in detail. Work on different types of free radical systems is summarized. Methods of hyperfine structure analysis are also described in detail. (P.C.H.)

1509 INVESTIGATIONS INTO THE PREPARATION AND DECOMPOSITION OF SAMARIUM TETRABORIDE AND SAMARIUM HEXABORIDE. Gordon Lynn Galloway. Thesis, East Lansing, Michigan State Univ., 1962. 111p.

Attempts to prepare pure samarium tetraboride either by the reaction between samarium sesquioxide and varying amounts of boron or by utilizing the direct reaction between the elements were shown to result only in mixtures of the tetra- and hexaborides. No evidence whatsoever was obtained to suggest the stable existence of a lower boride such as samarium diboride or a higher one such as samarium dodecaboride. The extent of contamination of the products of any reaction used to prepare a preponderance of one or the other of the borides was shown to be a function of the starting composition of the reactants, the temperature and duration of the heating, and, in some cases, the nature of the heating cell used to confine the reactions. Changing only the starting composition of mixtures of samarium sesquioxide and boron examined at 1650° in a crucible of boron nitride resulted in a smoothly continuous variation in the ratio of boron to oxygen lost on heating. This result, coupled with accompanying weight data, was interpreted as evidence of the non-validity of any single equation to describe the reaction simply. A survey was made of some of the materials suitable for use as crucibles at these high temperatures and details of this study are presented. The apparent stability of samarium tetraboride and samarium hexaboride at various temperatures was shown to be dependent upon the matrix material with which these borides were in contact. The existence of the equilibrium $3\ SmB_4(s) = 2\ SmB_6(s) + Sm(l,g)$ was ultimately verified as a result of observations on the diffusion and evaporation phenomena occurring within the system. When samarium tetraboride-hexaboride mixtures were heated in a crucible of boron nitride, the top surface of a sintered compact was observed to become depleted in samarium tetraboride and rich in samarium hexaboride; complete conversion was brought about by continued heating. However, when in contact with a matrix capable of absorbing boron into its interstices at a sufficiently high rate, a sintered mixture of samarium hexaboride was found to contain samarium tetraboride on its top surface after being heated at temperatures higher than those at which this tetraboride is normally unstable with respect to the hexaboride. These observations are explained in terms of a competition between equilibrium, rates of evaporation of samarium from the heating cell, and rates of diffusion of samarium to evaporation sites. (Dissertation Abstr., 23: No. 3, 1962)

1510 METHOD OF INHIBITING SPONTANEOUS OXIDATION OF URANIUM DIOXIDE POWDERS. Yvette Carteret, Pierre Chenebault, and Roger Delmas (to Commissariat à l'Énergie Atomique). Canadian Patent 646,474. Aug. 7, 1962.

A method for inhibiting the spontaneous oxidation of UO_2 powders is outlined which comprises adsorbing at least one gaseous inhibitor on the powder. The inhibitor may be CO_2, NH_3, H_2O, CCl_4, alcohols, ketones, or hydrocarbons, and the ratio of the adsorption equilibrium pressure to the maximum pressure used in the adsorption should be in the range of 0.05 to 1. (D.L.C.)

1511 YTTRIUM AND RARE EARTH BORATES. Albert A. Ballman (to Bell Telephone Labs., Inc.). U. S. Patent 3,057,677. Oct. 9, 1962.

A method is given for growing single crystals of $RX_3B_4O_{12}$, where R is Y or a rare earth of atomic number 62 to 68 and X is Al or Cr. The method comprises heating the constituents to ~1200°C in a flux mixture of a molybdic oxide and a potassium compound, and slowly cooling the resulting melt to precipitate crystals of the desired borate. (D.L.C.)

1512 METHODS OF OBTAINING SINTERED BERYLLIUM OXIDE. Emile Pruvot, Paul Baradez, Rober Caillat, and Roger Pointud (to Commissariat a l'Energie Atomique). U. S. Patent 3,057,684. Oct. 9, 1962.

A method is given for preparing sintered beryllium oxide of high density and purity. The method comprises adding a mineral acid or a beryllium salt thereof to beta-beryllium hydroxide, heating the salt–hydroxide mixture to form a beryllium oxide containing a little more than 1% of the salt, and sintering the oxide mixture. The beryllium salt must be one which decomposes to beryllium oxide under the sintering conditions and is preferably beryllium sulfate. (D.L.C.)

Organic Chemistry

1513 (BMI-X-10021) RADIOISOTOPE AND RADIATION APPLICATIONS. Quarterly Progress Report. Duane N. Sunderman, ed. (Battelle Memorial Inst., Columbus, Ohio). Oct. 18, 1962. Contract W-7405-eng-92. 15p.

The study of the mechanism of free-radical formation and decay in polymeric materials was continued and extended to include an investigation of the potential application of this information to the development of novel graft copolymers. The study of postirradiation grafting techniques employing both peroxide initiation and direct grafting was continued. In addition, the effect of molecular weight on site formation was further investigated. Licenses and license applications for approximately 300 by-product material licenses were reviewed to obtain information on environmental conditions of source usage. The feasibility of testing sealed-source response to normal environments by accelerated test procedures was studied. Indications are that the approach will probably not be applicable to either vibration or abrasion stresses but may be for corrosion stresses. (auth)

1514 (TID-17213) ELECTRON PARAMAGNETIC RESONANCE STUDIES OF TRIPLET STATES AND ENERGY TRANSFER. B. Smaller and J. R. Remko (Argonne National Lab., Ill.). Aug. 1962. Contract [W-31-109-eng-38]. 11p. (UAC-6778)

Triplet state concentrations of combinations of organic phosphors dissolved in a common glassy matrix could be studied and identified unambiguously by electron paramagnetic resonance. The zero-field splittings for a series of aromatic, substituted aromatic, and heterocyclic compounds' triplet states are given along with the determined line widths. The substitution of nitrogen for carbon in the ring had little effect. The line widths were determined by nuclear magnetic broadening. Relative triplet concentration of both energy donor and acceptor were determined for a great many pairs of phosphors and energy transfer verified, the prime requirement being that the triplet level of the donor lie above that for the acceptor. Analysis of the data revealed that the sum of the triplet state concentrations of both acceptor and donor is constant, independent of acceptor concentration, while the ratio of acceptor to donor triplet states is linearly dependent on the acceptor concentration. Several of the models proposed in an attempt at a correct theoretical interpretation of the energy transfer phenomenon are discussed. (M.C.G.)

1515 POLAROGRAPHIC FOLLOWING OF COMPLEXES OF URANIUM WITH PROPIONATE, FORMATE, AND MONOCHLOROACETATE. J. Hála and A. Okáč (Purkyne University, Brno). Collection Czech. Chem. Commun., 27: 1697-1701(July 1962). (In German)

For the study of complex systems in buffered solutions with definite pH, it is necessary to have a knowledge of the intermediate reactions of the primary solutions and to estimate the stability of the complexes with the buffer. The acetate complex region earlier studied was extended to a polarographic investigation of U complexes with propionate, formate, and monochloroacetate. It was possible to establish differences caused by the nature of these ligands. (tr-auth)

1516 THE FORMATION OF FREE RADICALS DURING THE INTERACTION OF HYDROPEROXIDES WITH CYCLOHEXANONE. E. T. Denisov (Inst. of Chemical Physics, Academy of Sciences, USSR). Doklady Akad. Nauk SSSR, 146: 394-7(Sept. 11, 1962). (In Russian)

Tertiary butyl hydroperoxide (purified by vacuum distillation) was reacted with cyclohexanone in chlorobenzene in the presence of α-naphthyamine as an inhibitor. The rate of formation of free radicals (W_i) was directly proportional to the concentration of hydroperoxide: $W_i = k_1$ [ROOH]. Hydroperoxide broke down into free radicals 7 times faster in cyclohexanone than it did in chlorobenzene. This indicated that the cyclohexanone reacts with the hydroperoxide compound. W_i first increased linearly with increasing content of cyclohexanone in the mixture, and then leveled off to a constant value. These results can be explained by the following mechanism for the formation of free radicals: $ROOH \xrightarrow{k_1} RO^* + OH^*$, ROOH + ketone $\rightleftharpoons$ X, $X \xrightarrow{k_2}$ free radicals. The rate of formation of free radicals in this system is: $W_i = k_1$ [ROOH] + k_2 X. Here [X] = K[ketone] [ROOH] and $W_i = (k_1 + k_2 K$[ketone]) [ROOH]. The rate constants for the break-down into radicals, and the equilibrium constant have the following form: $k_1 = 1.8 \times 10^{12}$ exp (−33,000/RT) sec^{-1}, $k_2 = 1.8 \times 10^9$ exp (−26,000/RT) sec^{-1}, and $K = 6.9 \times 10^{-7}$ exp (11,000/RT) l/mol. The results show that an intermediate addition product can be formed in the liquid-phase oxidation of a hydrocarbon. (TTT)

1517 ON THE IONIZATION POTENTIAL OF THE CH_2 RADICAL. J. Berkowitz and S. Wexler (Argonne National Lab., Ill.). J. Chem. Phys., 37: 1476-8(Oct. 1, 1962). (TID-16212)

A marked difference has existed between the ionization potential of the methylene radical as measured by flash photolysis (10.396 ev) and by mass spectrometry (11.75 ev). A reinvestigation of the mass spectrometric experiment, undertaken to resolve the discrepancy, did not confirm the value previously reported. No evidence could be obtained

for the formation of CH_2^+ from CH_2 formed by pyrolysis of CH_3N_2, although the formation of CH_3^+ from CH_3 formed by pyrolysis of $(CH_3)_2$ Hg could be readily detected. (auth)

1518 STUDIES ON COORDINATION COMPOUNDS OF URANYL ACETATE WITH ORGANIC ACIDS. I. THE SYSTEM: URANYL ACETATE-MANDELIC ACID-WATER. C. S. Pande and S. K. Misra (Lucknow Univ., India). J. Prakt. Chem., 17: 5-12(June 1962).

Conductometric and pH studies of the mixed solutions of uranyl acetate and mandelic acid revealed the existence of two complex compounds in (1 : 1) and (1 : 2) molecular ratios. The compounds were isolated in the pure state, and the constitution was established by estimating the amounts of uranium and mandelic acid present in the isolated samples. (auth)

1519 STUDIES ON COORDINATION COMPOUNDS OF URANYL ACETATE WITH ORGANIC ACIDS. II. THE THE SYSTEM: URANYL ACETATE-LACTIC ACID-WATER. C. S. Pande and S. K. Misra (Lucknow Univ., India). J. Prakt. Chem., 17: 13-20(June 1962).

Conductometric, colorimetric, and pH observations of the mixed solutions of uranyl acetate and lactic acid revealed the existence of two complex compounds in (1 : 1) and (1 : 2) molecular ratios. The compounds were isolated in the pure state and the constitution was established by estimating the amounts of uranium and lactic acid present in the isolated samples. (auth)

1520 EVALUATION OF ISOTOPE EXCHANGE BY CHROMATOGRAPHY. J. Morávek, Z. Nejedlý, and J. Filip (Inst. for Research, Production, and Uses of Radioisotopes, Prague). Science, 138: 146-7(Oct. 12, 1962).

The study of exchange reaction kinetics between sulfur-35 and organic compounds which contain sulfur can be made much easier by use of paper radiochromatography. Activity ratios of the components of the reaction mixture can be estimated by use of very small amounts of radioactive materials. The reaction need not be halted and individual components need not be isolated. Any degradation of reacting substances can be measured quantitatively at the same time. (auth)

1521 THE SCINTILLATION ANISOTROPY OF ANTHRACENE AT LOW TEMPERATURES. [PART] II. P. H. Heckmann, W. Sander, and A. Flammersfeld (Universität, Göttingen, Ger.). Z. Physik, 169: 17-22(1962). (In German)

The scintillation anisotropy of anthracene bombarded with α particles was measured as a function of temperature between 1.9 and about 80°K. With all crystal specimens investigated, a pronounced minimum was found between 20 and 30°K. The anisotropy is constant below about 9°K, whereas the light yield still increases with decreasing temperature down to 1.9°K. The light yield was found to be a nonlinear function of the temperature. (auth)

1522 COMPARISON OF THE EFFECT OF ELECTRON IRRADIATION ON THE OPTICAL ACTIVITY OF RACEMATES AND OPTICAL ANTIPODES. V. I. Goldanskii and V. V. Khrapov (Inst. of Chemical Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 43: 823-7 (Sept. 1962). (In Russian)

In connection with the assertions repeatedly appearing in the literature that electrons emitted during β decay or even accelerated in a microtron exert different effects on mirror isomers (antipodes), a detailed experimental investigation of the effect of electron irradiation of solid racemates and separated forms of optical isomers on their optical activity has been carried out for fourteen different organic compounds. The electron sources used were the β^- active isotope Rh^{104}, the microtron, and a cascade accelerating tube. In all cases investigated neither the appearance of optical activity of the irradiated racemates nor a difference in the action of irradiation on the optical antipodes was observed. (auth)

1523 BERYLLIUM OXYBENZOATE COMPOUNDS WITH AROMATIC HYDROCARBONS. G. M. Kurdyumov and K. N. Semenenko. Zh. Neorgan. Khim., 7: 2115-21 (Sept. 1962). (In Russian)

Preparations and properties of equilibrium compounds of $Be_4O(C_6H_5COO)_6 \cdot 3x$—liquid hydrocarbon and $Be_4O(C_6H_5COO)_6 \cdot 3x$—gaseous hydrocarbon (where x is benzene, toluene, or styrene) were studied, and the heats of dissociation of respective inclusions in these compounds were determined. (R.V.J.)

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Refer also to abstract 2519.

1524 (AWRE-NR/A-2/62) A TECHNIQUE FOR MEASURING THE TRITIUM CONTENT OF SMALL SAMPLES OF IRRADIATED LITHIUM METAL. P. W. Benjamin, C. D. Kemshall, and D. L. E. Smith (United Kingdom Atomic Energy Authority. Weapons Group. Atomic Weapons Research Establishment, Aldermaston, Berks, England). Oct. 1962. 24p.

A technique is described for extracting tritium from 1 g lithium metal samples, and for counting the β activity of the tritium in a low-background counter. The method is useful for quantities of tritium having activities greater than 5 disintegrations per minute. The absolute accuracy of the method is discussed. The probable error on any one measurement being 3.5%. Using this technique the cross section for the reaction $Li^7(n,n')\alpha,T$ at 13.98 Mev was measured and was found to be 347 ± 9 mb. (auth)

1525 (ORNL-3346) LOW TEMPERATURE THERMOLUMINESCENCE OF GAMMA IRRADIATED POTASSIUM DIHYDROGEN PHOSPHATE (thesis). Travis M. Sims (Oak Ridge National Lab., Tenn.). Oct. 19, 1962. Contract W-7405-eng-26. 68p.

Thermoluminescence in potassium dihydrogen phosphate (KDP) induced by Co^{60} gamma irradiation at liquid nitrogen temperature (−196°C) was investigated. Glow curves in the temperature range −196 to 0°C were measured for a series of gamma exposure dosages ranging from 10^4 roentgen to 5×10^6 roentgen. The heating rate used for glow curve measurements was 12°C per minute. Twice recrystallized Mallinckrodt reagent grade potassium dihydrogen phosphate, with a grain size between 100 and 170 mesh, was used for most samples. In the case of the powder samples, the glow curve for an exposure dose of 10^4 roentgen exhibited two peaks in this temperature range, one at approximately −78°C and the other at approximately −146°C. The −78°C peak split into two distinct peaks with increasing dosage. At still higher doses an additional peak at about −9°C became evident. This peak may, however, be due to aluminum oxide. Calculation of the trap depth, E, and the frequency factor, s, associated with the −78°C peak, by the approximate method of Grossweiner yielded values of 0.485 ev and 9.97×10^{10} sec^{-1} for E and s, respectively. Calculation of the trap depth corresponding to this glow peak was also made using the method described by Bonfiglioli, Brovetto, and Cortese. The value obtained was ~0.2 ev. Treatment of the −148°C glow peak by the method of Bonfiglioli, Brovetto, and Cortese gave values of

~0.1, ~0.35, and ~0.2 ev for glow curves resulting from exposure doses of 10^4, 10^5, and 10^6 roentgens, respectively. Glow curves were measured for two KDP single crystals, each exposed to 10^4, 10^5, and 10^6 roentgens with subsequent warming to room temperature between exposures. The temperatures at which core glow peaks for a given exposure dose occur agreed within 5°C for both samples. However, the relative intensity of corresponding peaks varied rather widely between samples. Flashes of light of short duration were observed during warming of many of the irradiated samples, both as powders and single crystals. It is suggested that this may be some form of triboluminescence. No exact correlation of this particular phenomenon with dose was attempted but it was generally observed more often at higher doses and never at 10^4 roentgens. (auth)

1526 (RRL-90) QUARTERLY REPORT [ON RADIOCHEMISTRY], JULY 1, 1962–SEPTEMBER 30, 1962. Fundamental Research No. 6041. (Mellon Inst. Radiation Research Labs., Pittsburgh). Oct. 15, 1962. Contract AT(30-1)-2310. 16p.

Recently radicals of the cyclohexadienyl type were postulated to explain the electron spin resonance spectra of irradiated aromatics. The spectra of 1,4-cyclohexadiene were studied during irradiation in the liquid phase. The resulting 72-line spectrum was due to the cyclohexadienyl radical. A study of the effect of dose rate on the ratio of butene-1 to hexane-1 yields from radiolysis of ethylene showed that the ratio increases with dose rate at −165°. The radical yields from cyclopentane and cyclopropane are being investigated. The primary processes in mercury-photosensitized decompositions of hydrocarbons are under study utilizing the ethylene–C^{14} scavenging technique. The photolysis of carbon tetrachloride was studied. Propane and butane formation was observed in addition to methane, ethane, ethylene, and acetylene when mixtures of methyl iodide and ethyl iodide were irradiated in the liquid phase. Primary steps in the radiolysis of i-propylbromide were investigated. Yields from radiolysis of deaerated aqueous isopropyl alcohol solutions are presented. (M.C.G.)

1527 (TID-17046) FISSION FRAGMENT IRRADIATION OF METHANE (thesis). Carl Wiern Farley (Pennsylvania State Univ., University Park). June 1962. Contract [AT(30-1)-2133]. 89p.

A study was made of the fission fragment irradiation of methane. The effect of temperature on the reaction was measured, a reliable method of measuring the energy absorbed in the methane was established, and fission fragments present in the gas were identified. The irradiation equipment consisted of a stainless steel tube which was coated on the outer surface with enriched uranium oxide and located at the center of a somewhat larger cylindrical pressure vessel. This assembly was fitted with several thermocouples and surrounded by electrical heaters. The gas chamber and heater were enclosed by a six-in.-dia., six-foot-long aluminum shell. It is possible to irradiate a stationary volume of gas or to continually circulate the gas during irradiation in this equipment; however, this investigation was limited to the stationary case. In a typical run, the cell was charged with methane, brought to reaction temperature, and placed adjacent to the reactor core face. The neutron beam from the reactor caused fissioning in the uranium, and about half of the resulting fission fragments escaped from the uranium fuel into the surrounding methane. Following irradiation and a two day cooling period, the gas was sampled and analyzed with a gas chromatograph. The dose received by the gaseous reactants could be reliably estimated either by cobalt wire activation or the data from the reactor instrumentation. At the two temperatures studied (165 and 300°C), the principal decomposition products of methane were hydrogen and small amounts of light hydrocarbons through C_5. While unsaturated hydrocarbons were detected, the amounts were considerably less than the corresponding saturated compounds with the same number of carbon atoms. At 300°C and a dose of about 1.5 watt-hours, the concentrations of nearly all of the hydrocarbon products passed through a maximum. At 165°C the concentrations of these products approached a maximum at the largest dose used. At a very low dose, the G-value of methane decomposed was about 18 at 165°C and 47 at 300°C. There was very little difference in the G-value for these two temperatures at a high dose; a value of about 12 was calculated for about 2.5 watt-hours. Xe^{133} was the only fission fragment found in the irradiated methane after several days cooling. (auth)

1528 (TID-17219) IONIC POLYMERIZATION INDUCED BY HIGH ENERGY RADIATION. Final Report. V. T. Stannett, J. A. Meyer, and M. Szwarc (New York. State Univ., Albany. Research Foundation). Oct. 30, 1962. Contract AT(30-1)-2569. 4p.

The effects of solvents on the radioinduced polymerization of isobutylene and styrene were studied. Both with pure isobutylene and with the styrene–methylene chloride system highly irreproducible results were obtained. Addition of water reduced the rate of polymerization and the molecular weight in both cases. However, isobutylene seemed to be far more sensitive to water than styrene. Increasing the glass surface area by up to six-fold caused no great changes in the rate or molecular weight. In nearly all the experiments with isobutylene the conversion curves were linear and without an induction period. The styrene conversion curves showed a decrease in rate after 10 to 20% conversion in every case. The polyisobutylene was continually undergoing degradation during the polymerization reaction. However, the polymer produced appeared to be more radiation resistant than the normal commercial polyisobutylene. Soluble additives of high electron affinity retarded the rate in nearly every case. (M.C.G.)

1529 UV AND X-RAY DEPENDENT PARAMAGNETIC RESONANCE ABSORPTION IN AMINO ACIDS AND ALBUMINS. R. Koch, J. Fraenz, and K. Markau (Universität, Freiburg i. B.). Atompraxis, 8: 345-50(Sept. 1962). (In German)

Cysteine-HCl, homocysteine, alanine, methionine, tryptophan, albumin, and fibroin were exposed to x rays (10^5 r) and/or uv. The paramagnetic resonance absorption spectra (ESR) were recorded at a microwave frequency of 9000 Mc. All amino acids containing sulfur showed both an x-ray- and a light-dependent spectrum. The same is true of both albumin bodies. Alanine and tryptophan have no uv signal, and in addition, tryptophan evidently develops no radical position even after x irradiation (10^5 r). X-ray and uv signals differ markedly from each other, except for cysteine and fibroin. In these two cases, x rays and uv have an additive effect. In the other cases, the x-ray signal is transformed into the uv signal by subsequent exposure. Possible explanations of this are discussed. (auth)

1530 RADIATION CHEMISTRY OF LIQUID ACETONE. II. FORMATION OF ACIDS IN OXIDATION RADIOLYSIS. P. Drienovskii. Collection Czech. Chem. Commun., 27: 1614-23(July 1962). (In Czech.)

In the radiolysis of liquid acetone in hydrogen or oxygen atmospheres, the acid products formed were analyzed. The

property of acetone permits the individual acid or acid products to be determined by potentiometric titration. In such a manner it was established that in the oxidation radiolysis, formic acid (yield 1.11 molecule/100 ev), acetic acid (yield 1.95 molecule/100 ev), and carbon dioxide (yield 2.19 molecule/100 ev) are produced. In irradiation of acetone saturated with hydrogen, acetic acid has a yield of 0.71 molecule/100 ev. It was shown that the enol form of acetone plays a significant role in the oxidation radiolysis of acetone. (tr-auth)

1531 RADIOCHEMISTRY OF LIQUID ACETONE. III. FORMATION OF FORMALDEHYDE. P. Drienovskii. Collection Czech. Chem. Commun., 27: 1624-32(July 1962). (In Czech)

It was established that formaldehyde with yields of 6.3 molecules/100 ev and 2.8 molecules/100 ev is formed in oxygen and hydrogen, respectively, from the x irradiation of acetone. The possibilities for the formation of formaldehyde by radiolysis of acetone were discussed from the viewpoint of the isomerization of free radicals. In the oxidation radiolysis of acetone, the post-effect of formaldehyde was determined. The concentration of the formaldehyde formed decreases after stopping the irradiation with velocities of 1.7×10^{-9} mol/ml/sec. After 25 to 30 min, calculated from the stopping of the irradiation, the concentration of formaldehyde begins again to increase, passes through a maximum, and decreases again to a definite constant value. The interpretation of the post effect depends on the polymerization of the formaldehyde which leads to the formation of trioxan. This polymerizes from the catalytic effect of the acids produced in the same medium, so that the highly reactive formaldehyde which can react with acetone is formed. (tr-auth)

1532 CROSS-LINKED POLYETHYLENE FOR WIRE AND CABLE. T. Torii, et al (Fujikura Cable Works, Ltd., Japan). Fujikura Densen Giho, No. 20, 55-71(May 1961).

The chemical process, β-irradiation, and Co^{60} γ-irradiation (2.5×10^6 to 8×10^7 r) for cross-linking of polyethylene are described. Studies made on the characteristics of the cross-linked polyethylene with respect to number of chains, softening temperature and flow point, compressibility, tensile strength, specific gravity and crystallinity, stress cracking, cold resistance, heat resistance, weather resistance, water absorbability, and electrical properties showed a great similarity. Hence, from the economic point of view, the chemical process would be superior. Characteristics, such as general properties of cables, the cut-through test, and the electricity flow test, of cross-linked polyethylene for use as an insulating material for power cables are discussed. (OID)

1533 ENRICHMENT OF Co^{60} BY UTILIZATION OF THE SZILARD-CHALMERS EFFECT IN THE NEUTRON IRRADIATION OF COBALT(III) ACETYLACETONATE. G. Grossmann and K. Prokert (Universität, Dresden). Isotopen Tech., 2: 199-200(July 1962). (In German)

By irradiation of Co(III) acetylacetonate in various channels of the WWR-S research reactors at Rossendorf, the specific activity obtainable at different irradiation times by utilization of the Szilard-Chalmers effect was determined. Because of the high γ radiation and the relatively high irradiation temperature, a specific activity of 70 mC/g Co with a yield of 80 to 85% was found. (tr-auth)

1534 RADIOLYSIS AND PHOTOLYSIS OF AQUEOUS FORMIC ACID. CARBON MONOXIDE FORMATION. G. E. Adams and Edwin J. Hart (Argonne National Lab., Ill.). J. Am Chem. Soc., 84: 3994-9(Nov. 5, 1962). (TID-16594)

Factors important in carbon monoxide formation in Co^{60} γ and ultraviolet light irradiated aqueous formic acid solutions were studied. G(CO) increased with increasing formic acid concentration, increasing temperature, with decreasing pH, and be added ferrous sulfate and hydrogen peroxide. The addition of formaldehyde and iodide ion decreased G(CO). In photolysis at 1849 and 2537 Å., ϕ(CO) increases with decreasing wave length, increasing temperature, and by added hydrogen peroxide. Under conditions where hydrogen peroxide or iodide ion absorbs the light, little or no carbon monoxide was formed. Added oxygen eliminates all carbon monoxide in both radiolysis and photolysis. Two separate free radical mechanisms were postulated. The radical CHO, formed by excitation of formic acid, is one precursor of carbon monoxide; and the COOH radical, whose conversion to carbon monoxide is promoted in acid solutions, by hydrogen peroxide and by ferrous sulfate, is the other intermediate. (auth)

1535 DETECTION OF RADICAL INTERMEDIATES IN THE RADIOLYSIS OF HYDROCARBONS WITH THE ETHYLENE-C^{14} SCAVENGING TECHNIQUE. Richard A. Holroyd and George W. Klein (Mellon Inst., Pittsburgh). J. Am. Chem. Soc., 84: 4000-4(Nov. 5, 1962). (RRL-81)

The ethylene-C^{14} scavenging method was used to determine individual radical yields in the radiolysis of n-pentane, n-hexane, and n-heptane. Secondary alkyl radicals were the predominant radical type observed in all cases. Rearrangement was absent; that is, only radicals that can be derived from the parent by loss of a hydrogen atom or an alkyl radical were formed. Only minor amounts of unsaturated radicals were observed. At 10° the total radical yields were 5.4, 5.6, and 4.8 for n-pentane, n-hexane, and n-heptane. Lowering the temperature to −70° decreased all secondary alkyl radical yields but did not affect the normal alkyl radical yields. Hydrogen abstraction reactions did not contribute to the radical yield at −70°; thus the results represent primary radical yields. The maximum observed value of $G_{C_4^{14}H_9}$, the yield of scavenged hydrogen atoms, indicated G_H must be greater than or equal to 1.4. (auth)

1536 THE PHOTOCHEMISTRY OF NITROGEN DIOXIDE AT 3130 AND 4050 Å. Francis E. Blacet, Thomas C. Hall, and Philip A. Leighton (Univ. of California, Los Angeles). J. Am. Chem. Soc., 84: 4011-17(Nov. 5, 1962).

In mixtures of nitrogen dioxide and O^{18}-enriched oxygen, scrambling in the O_2 and transfer of O^{18} to the NO_2 were produced by irradiation at 3130 Å, but not at 4050 Å. Added gases were more effective in quenching the nitrogen dioxide photolysis at 4050 Å than at 3130 Å. At both wave lengths nitrogen dioxide reacted with isobutane to form t-nitroisobutane. The quantum yield of this reaction with 6 mm NO_2 and 1 atm i-C_4H_{10} was ≈0.1 at 3130 Å and ≈0.35 at 4050 Å, while that of the photolysis with 6 mm NO_2 alone was 0.96 at 3130 Å and 0.36 at 4050 Å. An activated molecule mechanism was capable of explaining these and other observations on nitrogen dioxide at 4050 Å. (auth)

1537 A COMPARISON OF THE RADIOLYSIS AND PHOTOLYSIS OF CYCLOPENTANONE. M. Katayama, J. C. Whitmer, and C. N. Trumbore (Univ. of Rochester, N. Y. and Univ. of Delaware, Newark). J. Am. Chem. Soc., 84: 4025-6(Nov. 5, 1962).

The major products of the γ radiolysis of cyclopentanone are reported as hydrogen, carbon monoxide, ethylene, and an oil. Yields of carbon monoxide and ethylene are uncertain because of secondary reactions setting in at about 0.001% conversion of the parent compound, but the hydrogen yield was constant with dose at $G(H_2) = 0.67$. The oil product was characterized as having a molecular weight of about

200 and retains much of the parent cyclopentanone character. The gas phase radiolysis qualitatively resembled the liquid phase radiolysis. A comparison is given between the radiolysis and photolysis of cyclopentanone which points up the need for shorter wave length photolysis studies of the system. (auth)

1538 PULSE RADIOLYSIS STUDIES. II. TRANSIENT SPECTRA AND RATE PROCESSES IN IRRADIATED ETHANOL AND AQUEOUS ETHANOL SOLUTION. I. A. Taub and Leon M. Dorfman (Argonne National Lab., Ill.). J. Am. Chem. Soc., 84: 4053-9(Nov. 5, 1962). (TID-16643)

The radiation chemistry of deaerated aqueous ethanol and deaerated liquid ethanol was studied by the pulse radiolysis technique. The same transient absorption spectrum, showing a broad weak absorption at about 290 mμ and stronger narrow peaks at 266, 257, and 247 mμ, was observed in both systems. It was concluded that the spectrum was that of the α-ethanol radical, CH_2CHOH. The molar extinction coefficient in water was estimated to be $\epsilon_{2967} = 230 \pm 55\ M^{-1}\ cm^{-1}$. From the rate curves for the disappearance of the transient, determined by fast photoelectric spectrophotometry, the absolute rate constant for the bimolecular reaction of two α-ethanol radicals in water, at 23°, was found to be: $2k_b = (1.1 \pm 0.3) \times 10^9\ M^{-1}\ sec^{-1}$. The bimolecular rate constant in ethanol, at 23°, was found to be: $2k_b = (3.3 \pm 0.2) \times 10^6\ \epsilon_{2967}\ M^{-1}\ sec^{-1}$, where ϵ_{2967} is the molar extinction coefficient at 2967 Å of the α-ethanol radical in ethanol. The radiation chemical yields of 2,3-butanediol and acetaldehyde were determined in both systems, along with the hydrogen yields in heavy water solutions. (auth)

1539 OPTICAL MEASUREMENTS ON ZnS:Cu PRODUCED BY NEUTRON IRRADIATION OF ZnS. R. M. Potter, M. Aven, and J. Kastner (General Electric Co., Cleveland). J. Electrochem. Soc., 109: 1154-62(Dec. 1962).

ZnS powder, irradiated in a high density thermal neutron flux, was partly converted to radioactive Zn^{65}, Zn^{69}, and S^{35}. These radioisotopes decay to Cu^{65}, Ga^{69}, and Cl^{35}, respectively. One week after removal from the nuclear reactor the sample was fired at 900°C to anneal out radiation damage occurring in the reactor. The brightness and spectral distribution under 3650 Å excitation and the diffuse reflectance spectra of the annealed sample were monitored during a period of 600 days. The principal results are interpreted in terms of an increasing concentration of uncompensated copper centers produced by the decay of Zn^{65}. (auth)

1540 SYNTHESIS OF SPECIFICALLY IODINE-131- AND CARBON-14-LABELED THYROXINE. Tetsuo Shiba and H. J. Cahnmann (National Inst. of Arthritis and Metabolic Diseases, Bethesda, Md.). J. Org. Chem., 27: 1733-8(May 1962).

A simple synthesis of various forms of radioactive L-thyroxine, carrying the label (I^{131} or C^{14}) either in the phenolic ring or in the nonphenolic ring and in the side chain, is described. It is based on the coupling of 4-hydroxy-3,5-diiodophenylpyruvic acid and 3,5-diiodotyrosine. Labeled 4-hydroxy-3,5-diiodophenylpyruvic acid was prepared by iodination of p-hydroxybenzaldehyde followed by condensation with acetylglycine and hydrolysis of the azlactone formed, or by enzymic oxidative deamination of diiodotyrosine. (auth)

1541 CHEMICAL EFFECT OF HIGH LEVEL GAMMA IRRADIATION ON BLOOD GLUCOSE IN VITRO. Linda Kay Rames and Harold S. Bailey (Univ. of South Dakota, Vermillion). J. Pharm. Sci., 51: 590-1(June 1962).

Furan-2,5-dicarboxylic acid was shown to be one of the decomposition products formed from high level gamma irradiation of blood glucose in vitro. With a Co^{60} source rabbit plasma received a dose of 23,760 r/hr or a total of 1,200,000 r in the 50.5 hr of irradiation. A 100-mg portion of synthesized furan-2,5-dicarboxylic acid was added to the irradiated plasma, and the carrier furan-2,5-dicarboxylic acid was then isolated from the irradiated system. Formation of furan-2,5-dicarboxylic acid in a biological system is dependent on the presence of glucuronic acid or galacturonic acid rather than that of glucose. This indicates that the first step in its formation from glucose would require oxidation to glucuronic acid or rearrangement and oxidation to galacturonic acid. The formation of radicals from the ionization of water provides a medium in which these oxidative processes are probable. The 2nd step would be the formation of ketohexose by further oxidation or rearrangement of glucuronic acid. Ring closure of the ketohexose would yield a heterocyclic ring containing oxygen with substituents on carbons 2 and 5. Dehydration of this structure by removal of 2 hydrogen and 2 hydroxyl groups would yield the furan ring. (H.H.D.)

1542 THE EFFECT OF PRESSURE ON RADIOLYSIS OF POTASSIUM NITRATE. Tung-Ho Chen and Everett R. Johnson (Stevens Inst. of Tech., Hoboken, N. J.). J. Phys. Chem., 66: 2068-9(Oct. 1962).

Chemically pure KNO_3 was irradiated with Co^{60} gamma rays in helium at 14 and 1900 psi pressure, and the NO_2^- yields were measured. The 1900 psi pressure had no effect on the NO_2^- yield vs dose graph up to the break at 4.5×10^{21} ev/g, but thereafter a decrease appeared in the yield. This pressure effect is interpreted as evidence for a lattice change occurring in KNO_3 after ~1 mole % decomposition from a dose of 4.5×10^{21} ev/g. (D.L.C.)

1543 RADIOCHEMICAL INVESTIGATIONS ON THE MULTIPLE FISSION OF URANIUM. III. THE FORMATION OF Cu^{67} IN THE THERMAL FISSION OF U^{235}. R. Muenze, O. Hladik, and G. Reinhard (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Kernenergie, 5: 564-5(July 1962). (In German)

In the separation of a copper fraction from the fission products of U^{235}, an activity was found that could be identified by the γ spectrum and half life as Cu^{67}. An estimation of the fission yield gave as an upper limit 10^{-4}%. (tr-auth)

1544 SEPARATION OF STRONTIUM AND CALCIUM WITH RHODIZONIC ACID IN RADIOCHEMICAL STUDIES. L. Hainberger and S. Cuadrado Sánchez (Pontifícia Universidade Católica, Rio de Janeiro). Mikrochim. Acta, 760-3(Mar. 28, 1962). (In German)

In experiments with Sr^{89} and Ca^{45} it was shown that Sr was selectively precipitated in alcoholic solution of rhodizonic acid. To avoid Ca contamination of the precipitated Sr rhodizonate, the reaction is carried out at acid pH (5.8), in the presence of the Ca-chelating agent N-hydroxyethylethylenediaminetetraacetate (HEDTA), and under boiling conditions. In the presence of large concentrations of Ca it is necessary to precipitate Sr rhodizonate several times. (H.H.D.)

1545 RADIATION-INDUCED CROSS-LINKING OF WATER-SOLUBLE POLYMERS IN THEIR AQUEOUS SOLUTIONS. Tatsuo Matsuda, Chen-chung Lin, and Kiyoshi Hayakawa (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 10: 728-31(Nov. 1961).

Radiation effects on mixtures of 2 of the following water-soluble polymers, PVA, PVP, PAM, MC, and PMAA, in aqueous solutions were studied by using Co^{60} γ rays at 6.2×10^4 r/hr at 25°C for 0 to 130 min. The concentration of each polymer in the solution was below the critical value

for gel formation, while a mixture of the polymers was above the critical value. Networks between 2 different polymer components were formed if both polymers were cross-linking types, but the network formation was retarded if one of the 2 polymers was a degradative type. The degree of cocross-linking in the PVA-PVP system was studied by viscosity measurements of the irradiated solutions and the solubility of the irradiated polymers in methanol. The gelation dosage for a mixture of 2 polymers was proportional to the ratio of polymer dissolved in the solution. The network formation of cross-linking-type polymers in their aqueous solutions was retarded by the presence of MC. (OID)

1546 RADIOLYSIS OF ASCORBIC ACID IN AQUEOUS SOLUTION BY GAMMA RADIATION. B. S. Narasinga Rao (Massachusetts General Hospital, Boston). Radiation Res., 17: 683-93(Nov. 1962).

Ascorbic acid was rapidly destroyed by γ radiation in dilute solutions. The main initial product formed was dehydroascorbic acid, which underwent further oxidation under irradiation. Formic, acetic, and oxalic acids, but not metaphosphoric acid, when present in solution reduced the radiation damage to ascorbic acid in varying degrees. Formic acid was very effective in this respect. Destruction of ascorbic acid by radiation was enhanced in the presence of oxygen, but the presence of dissolved CO_2 caused a considerable decrease in ascorbic acid oxidation by radiation. The mechanisms of ascorbic acid oxidation by radiation in aqueous solution are discussed. It is shown that the initial yields are in good agreement with those predicted by certain extensions of the series of radical reactions previously proposed by others. (auth)

1547 THE RADIOCHEMICAL SYNTHESIS OF GRAFTED POLYMERS. Adolphe Chapiro. Rev. Gen. Caoutchouc, 39: 593-9(Apr. 1962).

Methods are described for direct grafting by irradiating a polymer in the presence of a monomer; grafting on a peroxidized polymer; grafting of a monomer on a polymer-containing trapped macroradical; and grafting by cross-linking of a mixture of polymers. The kinetic aspects of the grafting reaction, such as the influence of the medium, the gel effect, the diffusion effect, and phase separation are discussed. Applications are also given. (OID)

1548 IRRADIATION-INDUCED GRAFT POLYMERIZATION ONTO CELLULOSE ACETATE. Yoshikazu Hachihama and Setsuo Takamuku (Osaka Univ.). Tech. Rept. Osaka Univ., 11: 431-7(Oct. 1961).

Results of graft polymerization of acrylonitrile (AN) or styrene onto cellulose acetate (with an acetyl content of 52.8%) obtained from several methods using a 1500-c Co^{60} γ-ray source are discussed. With the preirradiation method, cellulose acetate was irradiated in the presence of air, and the quantity of peroxides formed increased linearly with increasing dosage and graft polymerization was initiated when AN heated up to 100°C. With the frozen radical method, a graft efficiency of 0.7 to 0.8 was obtained. With the mutual graft polymerization method, only a small dosage was needed; however, the efficiency was very low, especially in the case of AN. The structures of the graft polymers were studied by saponification and successive extraction of the homopolymer formed. Approximately 38% of the grafted polystyrene was bound to the acetyl groups of the cellulose acetate. (OID)

1549 THE MECHANISM OF THE β-DECAY INDUCED INTRODUCTION OF TRITIUM IN THE TOLUENE MOLECULE. H. J. Ache and W. Herr (Universität Cologne and Kernforschungsanlage Jülich, Ger.). Z. Naturforsch., 17a: 631-8(Aug. 1962). (In German)

The mechanism of the Wilzbach method for tritium labeling was studied in toluene vapor, and some of the factors which affect the yield as well as the tritium distribution in the molecule were determined. It was shown that the L value (number of tritium-labeled molecules per tritium decay) is dependent on the mass of the T_2 used and increases from L = 0.71 with the use of 50 mC to L = 5.5 for 500 mC of tritium. Another important parameter, the reaction time, was determined. Whereas the tritium substitution in the nucleus increases linearly, the tritium introduction into the methyl group of the toluene increases exponentially with time. Two reaction paths, which lead to the labeling of the toluene, were discussed: (1) The β-induced mechanism along the (He^3T) ion and (2) radiolysis, that is, the effect of the β radiation, in which ionized, excited, and radical forms of the toluene occur. The contribution of the first reaction to the labeling could be fixed or eliminated if the HT molecule was used in place of T_2. The results indicate that the percentage of T substitution, which occurs from reaction 1, is dependent on the mass of tritium introduced. Whereas with 50 mC T_2 approximately 95% of the toluene is labeled in the first reaction, with 300 mC only 60% was labeled. The addition of 1 Torr O_2 shows, moreover, that the decay-induced labeling reaction can be attributed to at least two single reactions, of which one leads to nucleus substitution and was not inhibited, whereas in the other, the methyl group was substituted, and this can be almost completely repressed with O_2. In this case the L value is shown to be independent of the T_2 concentration. The L values of the "radiochemical" fraction increase with the T_2 mass used. (tr-auth)

1550 VERÄNDERUNG VON STÄRKELÖSUNGEN BEI EINWIRKUNG VON γ-STRAHLEN (Co^{60}) IN ABHÄNGIGKEIT VON DER DOSIS. (Changes in Starch Solutions After Co^{60} γ-Irradiation). Klaus-Peter Gerhards. Thesis, Bonn, Rheinische Friedrich-Wilhelms-Universitat, 1961. 48p.

The changes in starch solutions were studied after irradiation with Co^{60} of various doses. Mondamin solutions were irradiated in test tubes with doses in the range 2,000–500,000 r and pH and viscosity were measured. As a test for chemical changes the colour was determined after precipitation with alcohol. The viscosity decreases with increasing dose. The first marked viscosity change can be observed after irradiation with 2,000 r. In the higher dose range the change rate decreases. No influence of dose rate was observed. The mean pH value of the non-irradiated solution was 5.3. After irradiation with 50,000 r a value of 3.95 was measured. It is concluded that the irradiation of starch solutions results in a splitting of the molecular chain. This process depends on the oxygen availability in the solution. (Gmelin)

1551 GAMMA-RAY INDUCED ADDITION OF TRIPHENYLSILANE TO ALKENES. Don Albert Roper. Thesis, Ann Arbor, Mich., Univ. of Michigan, 1961. 78p.

The addition of silicon hydrides to alkenes is an important method for preparing certain organo-silicon compounds. Degassed solutions of triphenylsilane and various alkenes are irradiated at room temperature with gamma rays from a cobalt-60 source. The dose rate is 2×10^{19} ev/hr and the dose 7×10^{21} ev. Under these conditions, triphenylsilane reacts with 1-hexene, 1-octene, 1-tetradecene, cyclopentene, cyclohexene, and 1-methylcyclohexene to give 1 : 1 addition products. The triphenylsilyl group in these products is bonded to the less hindered carbon of the double bond. For example, triphenylsilane and 1-hexene give 1-triphenylsilylhexane. The G value is taken as the number of molecules of pure adduct isolated per 100 ev of radiation energy absorbed by the sample. With 1-hexene G values of

200 are obtained when a 2:1 mole-ratio of triphenylsilane to alkene is used. The chemical yields in these runs are 60% of theory. Under similar conditions, the naphthenes give poor yields and 2-hexene does not react. The reduced reactivity of triphenylsilane with these olefins is caused by steric effects. The reaction between triphenylsilane and 1-hexene is considered in some detail. The G value seems to be independent of slight changes in the dose rate. For doses up to 7×10^{21} ev, the G value rises linearly with the dose. The G value decreases with increase in the concentration of 1-hexene. On varying the 1-hexene-triphenylsilane mole ratios from 0.50 to 2.0, the G values vary from 200 to 70. The magnitudes of these G values are indicative of a chain process for the addition reaction. In searching for solvent effects, benzene or n-hexane is added to solutions of triphenylsilane and 1-hexene. The addition of benzene has no effect on the G value. However, the presence of n-hexane promotes the addition of triphenylsilane to 1-hexene. The increase in the G value is thought to be caused by a transfer of energy to triphenylsilane by the n-hexane. This results in an increase in the number of excited triphenylsilane molecules and hence the number of triphenylsilyl radicals. (Dissertation Abstr., 22: No. 7, 1962)

1552 STUDIES OF THE REACTIONS OF RECOIL TRITIUM ATOMS. Wilford Joseph Hoff, Jr. Thesis, Princeton, N. J., Princeton Univ., 1962. 60p.

The reactions of the recoiling tritium atoms from the $Li^6(n,\alpha)T$ reaction in methanol, ethanol, and acetone were studied. Attempts were made to account chemically for all of the non-gaseous tritium produced in neutron irradiations of solutions of lithium salts in these solvents. In addition to mixtures of lithium salts and organic solvents, pellets of lithium chloride were irradiated alone and then added to liquid samples of ethanol, acetic acid, and acetone. Attempts were made to account for the non-gaseous tritium released upon solution of these pellets in the organic solvents. The solvent irradiations were carried out under a variety of experimental conditions so that the effects of temperature, changes of state, the presence or absence of air, the presence of a radical scavenger (diphenyl picryl hydrazyl) and varying amounts of water could be investigated. Comparison of the total non-gaseous activity with the sum of that found in each chemical species indicates, within the errors, that the major non-gaseous tritium products have been identified. In methanol, ethanol, and acetone, the most important reactions leading to non-gaseous products are: (1) $T + \equiv C-H \rightarrow \equiv C-T + H$, (2) $T + \equiv C-CH_3 \rightarrow \equiv C-T + CH_3$, (3) $T + CH_2OH \rightarrow -CTO + H + H$, (4) $T + \rangle C{=}O \rightarrow T-\overset{|}{\underset{|}{C}}-OH$, (5) $T + {=}O \rightarrow -OT$, or $T + -O- \rightarrow -OT$. The effects of exchange reactions, radiation damage, dissolved species, temperature of irradiation, and phase of solvent on the above reactions are discussed. Many related investigations were also performed. These investigations and the pertinent conclusions are summarized. The results are interpreted on the basis of two separate and distinct processes: (1) Reactions which occur while the recoiling tritium atom still possesses a comparatively high energy. These reactions are uninfluenced by dissolved reactive substances. The products of these energetic, or "hot," reactions are all simple relatives of the parent molecule, and can be obtained by the reaction of the recoil tritium atom with a single solvent molecule. This is in agreement with the mechanism proposed for previous investigations of the $Li^6(n,\alpha)T$ reaction in organic media and also in agreement with the subsequent experiments on gas phase reactions of recoiling tritium atoms. The mechanism of these reactions is discussed both for condensed media and for gas phase irradiations. (2) Reactions which occur after the recoiling tritium atom has reached very low energies, perhaps essentially thermal. The yield of particular products in these very low energy or thermal reactions is dependent upon competitive reactions involving dissolved species as well as the solvent molecules. In the investigations utilizing the irradiated pellets of lithium chloride, it was assumed that a nearly uniform distribution of the tritium produced by the $Li^6(n,\alpha)T$ reaction would be throughout the inorganic lattice. When this lattice is subsequently destroyed by solution of the salt in one of the solvents, this tritium, if not already in stable combination, could be freed to react with molecules of the solvent. Reactions involving free hydrogen atoms or ions could well be expected to account for such reactions. The effects of varying the temperature of irradiation, the solvent temperature, and the dissolved solute were determined. Lithium chloride pellets irradiated at room temperature did not produce non-labile tritium in any of these solvents. Lithium chloride irradiated at −196°C and maintained at this temperature until they were added to an organic solvent produced non-labile tritium in acetone but not in acetic acid or ethanol. The effect of temperature of the solvent and of added solutes is discussed. A lack of reproducibility occurred both in the activity as labelled acetone and in the total amount of activity in the solution. Some of the possible contributing factors to this irreproducibility are discussed. These experiments indicate that the tritium atoms in the lithium chloride lattice are capable of undergoing at least two reactions upon solution in acetone: (1) $T + CH_3COCH_3 \rightarrow TCH_2COCH_3 + H$ (2) $T + {=}O \rightarrow -O-T$. Reaction to form HT is probable but was not verified in these experiments. In solutions containing hydroxyl groups, the reaction (3) $T + -OH \rightarrow -OT +$ . . . is the predominant one leading to non-gaseous products. Several explanations for the reactivity of the tritium in reaction (1) above are suggested. (Dissertation Abstr., 23: No. 3, 1962)

1553 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF POLYMERIC MATERIALS. Thomas Ffrancon Williams and Trevor Hugh Bates (to United Kingdom Atomic Energy Authority). British Patent 908,192. Oct. 17, 1962.

A method is given for producing polymers of beta-pinene. The method comprises subjecting beta-pinene to ionizing radiation in the absence of oxygen and water vapor. The resulting polymers are formed in high yield and have molecular weights of 1200 to 1500, and their differences from the commercial polymers by Friedel-Crafts catalysts are described briefly. (D.L.C.)

1554 POLYMERIZATION OF VINYL COMPOUNDS. William H. Yanko and John D. Calfee (to Monsanto Chemical Co.). U. S. Patent 3,058,899. Oct. 16, 1962.

A process is given for producing solid polymers in high yields from vinyl compounds. The process comprises subjecting the vinyl compounds at high pressures (>5,000 psi) to ionizing radiation. Examples of the process are given in which ethylene, 1-chloro-1-fluoroethylene, and a mixture of vinyl chloride and 1-chloro-1-fluoroethylene were polymerized with gamma radiation and pressures up to 40,000 psi. (D.L.C.)

Raw Materials and Feed Materials

Refer also to abstract 1704.

1555 (CEA-2161) PRÉPARATION DE L'HEXAFLUORURE DE PLUTONIUM. RECUPERATION DU

PLUTONIUM DES SCORIES D'ELABORATION. (Preparation of Plutonium Hexafluoride. Recovery of Plutonium from Waste Dross). R. Gendre (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). 1962. 156p.

The influence of various physical factors on the rate of fluorination of solid plutonium tetrafluoride by fluorine was studied. In a horizontal oven with a circulation for pure fluorine at atmospheric pressure and 520°C, at a fluorine rate of 9 liters/hour, it is possible to transform 3 gm of tetrafluoride to hexafluoride with about 100% transformation and a recovery yield of over 90%, in 4 to 5 hours. The fluorination rate is a function of the temperature, the fluorine flow rate, the crucible surface, the depth of the tetrafluoride layer, and the reaction time. It does not depend on the diffusion of the fluorine into the solid but is determined by the reaction at the gas-solid interface and obeys the kinetic law $(1 - T_T)^{\frac{1}{3}} = kt + 1$. The existence of intermediate fluorides, in particular $Pu_4 F_{17}$, was confirmed by a break in the Arrhenius plot at about 370°C, by differences in the fluorination rates inside the tetrafluoride layer, and by reversible color changes. The transformation to hexafluoride occurs with a purification with respect to the foreign elements present in the initial plutonium. A study was made of plutonium recovery from waste based on the transformation of occluded plutonium particles to gaseous hexafluoride which is then decomposed thermally to the tetrafluoride which can be reintroduced directly in the production circuit. Under the conditions considered this process is not applicable industrially. After milling, it is possible to separate the dross into enriched (75% Pu in 2.6 wt.% of dross) and depleted portions. By prolonged fluorination (16 hrs) of the various fractions it is possible to recover about 80% of the plutonium. A treatment plant using fluidization should make it possible to substantially improve the yield. (auth)

1556 (NLCO-860) SUMMARY TECHNICAL REPORT [ON FEED MATERIALS] FOR THE PERIOD JULY 1, 1962 TO SEPTEMBER 30, 1962. R. Burgett, ed. (National Lead Co. of Ohio, Cincinnati). Oct. 31, 1962. Contract AT(30-1)-1156. 76p.

Laboratory tests indicated that undissociated ammonia can be used advantageously to reduce UO_3 to UO_2. Kinetic data are given for the hydrofluorination of UO_2 from Hanford-source UO_3 under various operating conditions. A seal was developed to prevent the mixing of dissociated ammonia and air in the R-O-R process equipment. Large UF_4–Mg briquettes were made having good physical strength and good reduction characteristics. Magnesium alloyed with lithium was used as the reductant for green salt in small-scale reductions. Drip crops pickled in HNO_3 were evaluated as remelt feed and were found deleterious to quality. An electron bombardment furnace was constructed for use with the Bendix time-of-flight mass spectrometer. Fuel cores were examined by x-ray-diffraction techniques in the radial, tangential, and longitudinal directions as functions of radial position. Stereographic projections were prepared of the fraction of an arbitrarily directed tensile stress resolved as shear stress on the various modes of a number of twinning systems. The stable corrosion product formed when uranium metal is exposed to moist atmosphere was identified as $UO_3 \cdot 2H_2O$. Electrochemical studies showed that chloride pitting of uranium fuel cores in aqueous solutions can be eliminated by the addition of sodium nitrite. An automatic coulometric titrator was constructed that permits accurate and rapid determination of chloride ions. (auth)

1557 URANIUM OXIDE RECOVERY AT CONSOLIDATED DENISON. Can. Mining Met. Bull., 55: 175-85 (Mar. 1962).

The recovery of uranium oxide is described. Discussion is given on ore-milling characteristics, crushing, grinding, neutral thickening and filtering, leaching and acid disc filtration, partial neutralization, washing thickeners, clarification, ion exchange, drying and packaging, precipitation, tailings neutralization, tailings disposal, reagent storage and handling, and sampling and analytical control. The flowsheet is also outlined. (P.C.H.)

1558 THE ROLL OF FLUORINE IN CHEMISTRY OF URANIUM. A. Level. Energie Nucl., 4: 278-86(July-Aug. 1962). (In French)

After a brief review of a fabrication cycle for U, the principal methods for the preparation of UF_4 and UF_6 are described. A résumé of the different methods for the separation of U by volatilization of UF_6 is given. (tr-auth)

1559 NEUERE VERFAHREN DER URANINDUSTRIE. (New Processes in the Uranium Industry). Gustav A. Fester. Stuttgart, Ferdinand Enke Verlag, 1962. 88p.

A survey of developments in the uranium processing industry, based chiefly on the Proceedings of the 2nd Geneva Conference on the Peaceful Uses of Atomic Energy, is given. Brief descriptions of uranium deposits and minerals, production figures, new ore extraction processes, a world survey of processes, and a world review of refining processes for production of uranium metal and pure uranium compounds are included, along with U. S. and foreign patents covering the years 1953–1959. German equivalents for some American and English terms and U. S. measurements are appended. A listing of books published in the field since 1949 and author and subject indexes are also included. (Uranium Abstr., No. 6, Sept. 1962)

1560 LIQUID-LIQUID EXTRACTION PROCESS FOR THE RECOVERY OF HIGH PURITY THORIUM OXIDE. Charles Christensen and John Dingle Prater (to Kennecott Copper Corp.). British Patent 907,187. Oct. 3, 1962.

In the process, an aqueous mineral acid solution of Th values is subjected to countercurrent extraction with a kerosene solution of an alkyl phosphate and also 5% dibutyl or tributyl phosphate. The resulting organic extract is stripped of Th by successive countercurrent extractions with H_2SO_4 and alkali metal carbonate solutions. Impurities may be stripped from the extract with HCl prior to Th stripping. The Th may be precipitated as the oxalate from the stripping solution and calcined to the oxide. (D.L.C.)

1561 A PROCESS FOR THE RECOVERY OF URANIUM AND THORIUM VALUES. (to Osterreichische Studiengesellschaft für Atomenergie G.m.b.H.). British Patent 907,720. Oct. 10, 1962.

A process is given for recovering U and Th values from natural water associated with oil deposits. The process comprises separating the solid matter from the water in any suitable way, dissolving the solids in HCl, and treating the solution with an ion exchange resin to remove the U and Th values. An example of the process is given in which oil well liquor is treated. (D.L.C.)

1562 METHOD AND APPARATUS FOR THE OBTAINMENT OF URANIUM FLUORIDE. Maurice Delange, Henri Huet, and Paul Vertes (to Commissariat à l'Énergie Atomique). Canadian Patent 643,382. June 19, 1962.

A furnace apparatus is designed for the production of UF_4 from UO_3. The UO_3 is reduced to UO_2 by a countercurrent NH_3 flow in a first furnace and then converted to UF_4 by a

countercurrent HF flow in second and third furnaces. A cooled conduit is provided between the first and second furnaces for absorbing the residual HF from the second furnace into granular UO_2. (D.L.C.)

1563 PROCESS FOR OBTAINING URANIUM OXIDE. Barend Verkerk (to Philips Gloeilampenfabrieken). Canadian Patent 645,088. July 17, 1962.

A process is given for preparing nonpyrophorous, sinterable uranium oxide with a stoichiometry near UO_2. The process comprises reducing the oxide at 700 to 1000°C and subsequently oxidizing the resulting dioxide in Ar or N_2 containing water vapor but no O_2 at the same temperature. In a preferred embodiment of the process, ammonium diuranate is dissociated and reduced, and then oxidized. (D.L.C.)

Separation Processes

1564 (IDO-14593) CHEMICAL PROCESSING TECHNOLOGY QUARTERLY PROGRESS REPORT, APRIL–JUNE 1962. J. R. Bower, ed. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Sept. 24, 1962. Contract AT(10-1)-205. 44p.

Aqueous zirconium fuel processing studies, directed at adapting the hydrofluoric acid process to continuous dissolution-complexing in order to increase the capacity of the ICPP process, resulted in determination of dissolution rates over a wide range of conditions. The addition of oxidants to 4.8M hydrofluoric acid used for the continuous dissolution of 3% uranium-Zircaloy-2 fuel decreased the amount of uranium-containing residue in the dissolver at the expense of a decreased dissolution rate. Oxidized fuel was dissolved in 4.8M hydrofluoric acid by use of heat to initiate the reaction; the oxide film remained behind as a dissolver residue. Uranium in the dissolver product was oxidized to the extractable form by one minute treatment at 92°C with aluminum nitrate complexer solution; only 59% was extractable after 24-hour treatment at room temperature. Several hundred hours operation of a continuous bench scale unit indicated that uranium buildup should not be a problem in the dissolver since an apparent equilibrium was soon established. After 650 hours of operation, a Monel dissolver showed some signs of localized corrosion but exhibited generally good resistance. Preliminary results in a study of aluminum alloy dissolution rates, initiated because of unusually slow dissolution of certain aluminum-based fuel elements, showed that nickel and copper ions in solution significantly retarded the dissolution rate while iron had an accelerating effect. Examination of specimens from the permanent ICPP raffinate storage tanks for aluminum process wastes indicated negligible corrosion to date. Electrolytic dissolution studies progressed to a bench scale basket-type dissolver operating at currents up to 500 amperes with Nichrome fuel. Sudden current failures were essentially eliminated by use of platinum liners and a canted dissolver basket, but sustained operation was not attained because of a gradual decline in current as dissolution caused recession of the contact points on the dissolving rods. An in-line solution analyzer for nitric acid and Nichrome salt concentrations in the dissolver effluent operated satisfactorily. Additional supporting studies include measurement of certain dissolver solution physical properties, comparison of cathode potential measurements with laboratory data on corrosion rates, determination of polarization resistance of platinum in nitric acid, and continued investigation of the effect of irradiation on electrolytic dissolver insulator components. Operation of the Demonstrational Waste Calcining Facility for 1050 hours during this period, under three different experimental conditions, demonstrated that the facility can be continuously operated in a routine manner and that the solids loading in the cyclone and scrubbing sections can be reduced to, and controlled at, satisfactory levels. Preparations are being made for a run with a sodium-24 spike to the feed to evaluate the final off-gas decontamination equipment prior to operation with high-level wastes. Supplemental pilot plant and laboratory studies include use of sand to control bed particle size, investigation of the role of boric acid and phosphoric acid in control of alumina crystal form, and exploratory studies on the nature of the products of calcination of stainless steel and Nichrome nitrates. Additional studies on an experimental air pulser showed good agreement between experimental data, analog simulation, and an approximate linear solution which can be studied by hand calculation methods. Further studies on the removal of tributyl phosphate and its decomposition products from dilute aqueous streams indicate that phosphorus species from plant solutions may be absorbed by, and eluted from, hydrous zirconium oxide. (auth)

1565 (RFP-267) SOME EFFECTS OF CRITICALITY CONTROL ON CHEMICAL ENGINEERING DESIGN. B. L. Kelchner, C. J. Pinamont, R. E. Troeltzsch, and R. A. Vandegrift (Dow Chemical Co. Rocky Flats Plant, Denver). July 9, 1962. Contract AT(29-1)-1106. 17p.

Four examples are given of the results of work toward satisfying both the chemical process requirements and the criticality considerations for chemical processing equipment. The use of fixed nuclear poisons when processing appreciable quantities of enriched uranium or plutonium in aqueous solution is described. Safe-dimension continuous processing equipment was developed to dissolve or leach solid process residues and to filter resulting aqueous slurries. Use of this equipment effectively avoids the hazards of batch processing. In evaporators the heat exchangers are limited to the maximum cylinder dimension. An annular cross section is used for the vapor-liquid separator. A fixed nuclear poison is used in the de-entrainment section. Criticality control in enclosures was improved by providing a criticality drain in the bottom of the enclosure. (M.C.G.)

1566 (USNRDL-TR-588) SOLUTE DISTRIBUTION IN THE $Na_2O-B_2O_3-NaCl$ SYSTEM. I. ALKALI METALS. M. H. Rowell (Naval Radiological Defense Lab., San Francisco). Oct. 9, 1962. Contract AT(49-2)-1167. 24p.

The distribution of trace amounts of Cs and Rb between immiscible liquid phases over a wide composition range in the system $Na_2O-B_2O_3-NaCl$ at 830°C was studied by means of Cs^{137} and Rb^{86}. Phase diagram data and distribution coefficients of the solutes were obtained during these equilibrations. The distribution of solutes is presented as a function of the compositions of the two conjugate phases. At low Na_2O content in the system the borate/salt distribution coefficients have the order Cs > Rb > Na, but at high Na_2O content the order is reversed. Other solutes such as Ca show a greater variation of distribution coefficient with phase composition than do alkali metals. An explanation of solute distribution is offered on the basis of changing borate network structure and the formation of ion exchange sites therein. (auth)

1567 PRELIMINARY STUDY OF ION EXCHANGE SEPARATION OF CERIUM EARTHS BY EDTA COPPER METHOD. Keijiro Nishigori. Denki Shikensho Iho, 26: 487-90(July 1962). (In Japanese)

Ion exchange separation of cerium earths was studied by treating 200 g of monazite sand. Fractional precipitation and crystallization were used to separate La, Ce, Pr, Nd, and Sm. Ion exchange purification was put into practice using these fractional parts. Amounts obtained were 12.2, 37.4, 3.7, 15.0, and 1.5 g of La_2O_3, CeO_2, Pr_6O_{11}, Nd_2O_3, and Sm_2O_3, respectively. (auth)

1568 A PULSED COLUMN FOR COUNTERCURRENT LIQUID-SOLIDS FLOW. Earl S. Grimmett and Blake P. Brown. Ind. Eng. Chem., 54: No. 11, 24, 26-8(Nov. 1962).

A pulsed liquid-solids contactor for handling radioactive solutions was developed which has only one moving part, a pulser. The contactor is continuous and has five stages with solids flowing down and liquids up. The operation characteristics and efficiencies are discussed in detail. (D.L.C.)

1569 THE INFLUENCE OF THE NATURE OF THE ORGANIC SOLVENT ON THE EXTRACTION OF CHELATE COMPOUNDS. I. P. Alimarin and Yu. A. Zolotov (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Talanta, 9: 891-9(Nov. 1962). (In English)

The influence of the nature of the organic solvent on the extraction of the thenoyltrifluoroacetonates of Np(V), Co(II), and Ce(III), the hydroxyquinolates of Np(V) and W(VI), the acetylacetonates of Co(II) and Fe(III), the 1-nitroso-2-naphtholate of Co(II) and other chelate compounds was studied. As a rule, coordination-unsaturated chelates (coordination number of the central atom greater than twice its charge, bidentate reagent) are extracted better by ketones, esters, and, particularly, by alcohols; and, normally, are less well extracted by ethers and by hydrocarbons and their halogen-substituted derivatives. The extraction of coordination-unsaturated chelates can in some cases by favored by the use of an excess of the reagent. Coordination-saturated chelate compounds (coordination number not greater than twice the charge, bidentate reagent) can be extracted by solvents of extremely diverse nature, including non-oxygen-containing solvents of relatively low polarity. Attention is drawn to the possibility of separating coordination-saturated and coordination-unsaturated chelate compounds. (auth)

1570 DIRECT EXTRACTION OF URANIUM BY ORGANIC SOLVENT. Hiroshi Tomishima (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rev., Intern. Ed., No. 10, 47-52(1962). (In English)

A new method is proposed for the extraction of pure U from oxides, carbides, or metals. The method comprises shaking a neutral organic solvent, e.g., TBP, with a HNO_3 solution to form a HNO_3-solvent complex in the organic phase, separating the aqueous phase, and treating the water-insoluble uranium solids with the treated organic phase. The advantages of this direct extraction method are that dissolution and extraction of U are combined in one stage, the non-dissolved residue after extraction settles rapidly, and the HNO_3 consumption is nearly equal to the theoretical amount required for U extraction. The mechanism of the direct extraction and the factors influencing the extraction rate are discussed. Practical applications of the method are considered, among which is reclamation of U from scrap and irradiated fuels. (D.L.C.)

1571 EXTRACTION OF URANIUM BY BINARY REAGENT MIXTURES. V. B. Shevchenko, V. S. Smelov, and A. V. Strakhova. Zh. Neorgan. Khim., 7: 1736-42 (July 1962). (In Russian)

Uranyl nitrate reactions with diisoamylmethylphosphinic acid (DAMPA) and tributylphosphine oxide (TBPO) were analyzed. Synergic extraction of uranium by mixed agents: TBP + MAMPA, DAMPA + DAPA, DAMPA + MAMPA, TBPO + DAPA, and TBPO + MAMPA was analyzed, and it is shown that $UO_2K_2 \cdot T$ compounds were extracted by the binary mixtures. The formation constants were calculated, and the influence of diluents was determined. (R.V.J.)

1572 DETERMINATION OF $Hf(NO_3)_i^{4-i}$ IONS BY TRIBUTYL PHOSPHATE EXTRACTION. N. P. Prokhorova and N. E. Brezhneva. Zh. Neorgan. Khim., 7: 1846-53 (Aug. 1962). (In Russian)

Solvent extractions of Hf complexes and complexing of Hf with nitrate ions were analyzed and the reaction constant for $Hf(NO_3)_4 + 2TBP \rightleftharpoons Hf(NO_3)_4 \cdot 2TBP$ was found to be 0.76. It was also found that Hf is extracted into the organic phase with two TBP molecules. The stability constants for $[Hf(NO_3)_2]^{2+}$, $[Hf(NO_3)_3]^{+}$, $[Hf(NO_3)_4]^{0}$, $[Hf(NO_3)_5]^{-}$, and $[Hf(NO_3)_6]^{2-}$ are 8.2, 32.7, 77.1, 119, 121, and 64.8, respectively. (R.V.J.)

1573 EXTRACTION OF CERIUM. G. V. Korpusov, V. I. Levin, N. E. Brezhneva, N. P. Prokhorova, N. V. Eskevich, and P. M. Seredenko. Zh. Neorgan. Khim., 7: 2254-61(Sept. 1962). (In Russian)

Separation of pure tetravalent cerium from a rare earth concentrate (11.57% La, 58% Ce, 6.8% Pr, 18% Nd, 2.7% Sm, 0.1% Eu, 1.4% Gd, 0.1% Tb, 0.25% Dy, and small amounts of other elements) in nitric acid by solvent extraction using TBP is described. (R.V.J.)

1574 METHOD OF REPROCESSING UO_2 REACTOR FUEL. (to U. S. Atomic Energy Commission). British Patent 907,830. Oct. 10, 1962.

A non-aqueous method for pulverizing sintered UO_2 reactor fuel bodies is given which also results in a partial decontamination of the bodies. The method comprises subjecting the bodies to at least one cycle of oxidation to U_3O_8 and reduction back to UO_2. The best temperature range for the oxidations is 300 to 500°C, and the temperature of successive cycles should be reduced gradually in order to obtain finer particles. One or a few of the cycles should be carried out at 600 to 1200°C to remove most of the Xe, I_2, Cs, Ru, Te, and Kr from the bodies. The oxidations should be carried out in air rather than O_2. (D.L.C.)

1575 PROCESS FOR THE SEPARATION OF ZIRCONIUM AND HAFNIUM. Adolf von Baeckmann (to Oskar Glemser). Canadian Patent 639,404. Apr. 3, 1962.

A process is given for the separation of Zr and Hf by solvent extraction. The process comprises distributing the chlorides of Zr and Hf between an aqueous solution of chloride ions and a liquid halogenated hydrocarbon containing an organic amine of medium molecular weight. The process has the advantages that repeated extractions may be carried out and that Zr oxychloride may be directly used. (D.L.C.)

1576 PROCESS FOR THE SEPARATION OF RARE EARTH METALS. Roberte Poulain, Irène Auguste, and Abram Averbuch (to Compagnie de Produits Chimiques et Electrométallurgiques). Canadian Patent 640,420. Apr. 24, 1962.

A process is given for the separation of rare earths by cation exchange. The process uses complexing agents such as EDTA or NTA as eluant and the "retaining ion" technique, where the retaining ion is one or more of the rare earths having higher atomic weights than those of the rare earths being separated. Several examples of the process are given. (D.L.C.)

1577 FLUORIDE VOLATILITY PROCESS FOR THE RECOVERY OF URANIUM. Joseph J. Katz, Herbert H. Hyman, and Irving Sheft (to Atomic Energy of Canada Ltd.). Canadian Patent 648,942. Sept. 18, 1962.

A process is given for separating U from Pu and fission products in irradiated U. The process comprises dissolving

the irradiated U in a halogen fluoride under such conditions that the volatile PuF_6 is not formed, and distilling off the volatile UF_6. The dissolution preferably is carried out in BrF_3 with F_2 or SbF_5 added to improve the dissolution reaction, and the formation of PuF_6 is avoided by continuous removal of the Br_2 and BrF products of the dissolution. (D.L.C.)

1578 PRODUCTION OF HAFNIUM-FREE ZIRCONIUM COMPOUNDS. Roger L. Pilloton (to Union Carbide Corp.). U. S. Patent 3,058,801. Oct. 16, 1962.

A simple process is given for separating Zr from Hf and vice versa. The process comprises dissolving the Zr and Hf tetrachlorides in an organic liquid which forms additional compounds with the chlorides, cooling the solution to 0 to −50°C, and precipitating $HfOCl_2$ from the solution by addition of concentrated HCl. After the $HfOCl_2$ is separated from the solution, $ZrOCl_2$ may be precipitated therefrom by adjusting the HCl concentration. The organic liquid preferably is n-propyl formate or n-butyl formate. (D.L.C.)

ENGINEERING AND EQUIPMENT

General and Miscellaneous

Refer also to abstract 1709.

1579 (AGN-TM-391-II) PECAN II—A CYCLE ANALYSIS CODE FOR GAS TURBINE, NUCLEAR OR CONVENTIONAL POWER PLANTS, MODIFIED FOR PROBLEMS INVOLVING INTERCOOLED COMPRESSORS (IBM 704 COMPUTER). S. Luchter and P. J. Du Bois (Aerojet-General Nucleonics, San Ramon, Calif.). Oct. 1962. Contract AT(10-1)-880. 23p.

The PECAN II cycle analysis code calculates various thermodynamic cycle data for gas turbine power plants, with one or two stage intercooling, based on a given set of design parameters. The code is restricted to the use of a gaseous working fluid within a temperature range of 300 to 3700°R, but is otherwise general. (auth)

1580 (CEA-2178) CONDITIONNEMENT EN TANT QUE DECHET RADIOACTIF DE GROS MATERIEL CONTAMINE EN α. (Treatment, as Radio-Active Waste, of Large Pieces of α-Contaminated Apparatus). P. Boutot, A. Capitaine, and L. Giachetto (France. Commissariat a l'Energie Atomique. Centre de Production de Plutonium de Marcoule, Chuscian). 1962. 17p.

Two solutions were adopted for treatment of contaminated apparatus: removal of the material from its original container and treatment in a special container; and treatment of the material directly inside its original protective packing. The treatment of a fluorination oven illustrates the second process. After a thorough cleaning of the enclosure, the oven is fixed in and the contamination held in place by a varnish. The assembly is placed in a special container and covered with shaken-down concrete. The container is shut by means of a welded cover. The operations are carried out under reduced pressure. At the end of this process it is impossible to detect any residual radioactivity. (auth)

1581 (NP-12181) FURTHER STUDIES ON THE DIFFRACTION OF A PRESSURE WAVE BY AN ELASTICALLY LINED CYLINDRICAL CAVITY IN AN ELASTIC MEDIUM. M. L. Baron and R. Parnes (Mitre Corp., Bedford, Mass.). Sept. 1952. Contract AF33(600)-39852. 20p. (SR-72)

Studies were made on the diffraction of a pressure wave in an elastic medium by a cylindrical cavity with an elastic liner. The elastic properties of the shell are different from those of the surrounding medium. The response of the shell due to the diffraction of the incoming pressure wave was previously evaluated. A parametric study was made of the influence of both the elastic properties of the medium and the steel shell stiffness on the intensity of the hoop stresses. It is shown that the use of a stiff shell in a soft medium produces a reduction in the hoop stress which has practical significance. The results can be used for design purposes for underground cavities located in competent rock subjected to air induced ground shock in the superseismic region of nuclear explosions. (auth)

1582 (UCRL-9787) DISPERSED-PHASE DISTRIBUTION PATTERNS IN LIQUID-LIQUID AGITATION. Lawrence H. Weiss, Jr., J. Leonard Fick, Robert H. Houston, and Theodore Vermeulen (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 6, 1962. Contract W-7405-eng-48. 92p.

The distribution of dispersed phase throughout a baffled tank was measured for a number of immiscible liquid pairs over a range of turbulent mixing conditions. The volume-fraction of dispersed phase, ϕ_s, was found to be independent of radial position. The variation of ϕ_s over the height of the agitator followed an exponential distribution function: $\phi_s = \phi_{max}\, e^{-\kappa(h-h_B)}$. The parameter κ represents the extent of inhomogeneity within the emulsion and is correlated by: $\kappa = 88\,[(N^2L^3\overline{\rho}/d_p g(1-\phi)|\Delta\rho|)^3\,(NLd_p\overline{\rho}/\mu_m)(LW/TH)^{4}]^{-1/5}$. The parameter h_B is the fractional tank-height of the boundary between the stagnant layer (if any) of the dispersible phase and the emulsified mixture. It was correlated by $h_B/\overline{\phi} = -1.39 \log_{10}[(N^2L^3\overline{\rho}/\sigma)\,(LW/TH)^{0.7}] + 2.31$, with the limitation that $\overline{\phi} \geq h_B \geq 0$. A criterion for complete bulk dispersion was obtained by setting the argument of the logarithm equal to 38. The inadequacies of single-parameter criteria are discussed. The results are compared with other studies of homogeneity in both liquid-liquid and liquid-solid systems. The available results are shown to be consistent for each system. (auth)

1583 (UVA-269-62U) SPRING AND DAMPING COEFFICIENTS IN BEARING ASSEMBLIES HAVING ONE AND TWO FLUID FILMS. R. L. Tomlin and H. M. Parker (Virginia. Univ., Charlottesville. Research Labs. for Engineering Sciences). Oct. 1962. Contract AT(40-1)-1779. 11p. (EP-4422-269-62U)

Bearings having circularly translating, nonrotating journals are considered; engineering accuracy type expressions are given for forces in the single-film bearing. Equations are derived for the dual-film bearing, and a scheme for solving these equations is given. (auth)

1584 REFRIGERATION PROCESSES BELOW 25°K WITH TURBO EXPANDERS. Christian Trepp. Ind. At., 6: 71-80(1962). (In French)

The losses produced in low-temperature installations are considered, and the most advantageous types of construction for refrigerating circuits with several expansion turbines are determined. The turbines used in Sulzer circuits are radial with one stage resting on oil bearings. One turbine with gas bearings is described. The cooling installation construction for the hydrogen bubble chamber at CERN is described. (tr-auth)

1585 NEW METHOD FOR THE SEPARATION OF RADIOACTIVE AEROSOLS. H. Israel and G. W. Israel (Technische Hochschule, Aachen). Naturwissenschaften, 49: 373(1962). (In German)

The constant increase of fission products in the atmosphere from nuclear bomb experiments and the danger of a catastrophic release in the case of reactor accident makes necessary the development of suitable methods for air decontamination. Since fission products are deposited almost completely on aerosols of the size of 0.02 to 1 μ, the problem of decontamination is synonymous with the removal of carrier aerosols in the air. A separation method is proposed which is based on the process occurring in nature for the formation of mists and clouds. Extensive studies are in progress to investigate the factors affecting this rain-out process. (J.S.R.)

1586 HOT CELL FACILITY AT RISØ. R. Kayser (Danish Atomic Energy Commission, Copenhagen) and P. A. L. Northcott. Nuclear Energy, 392-7(Oct. 1962).

A hot cell facility was constructed at Risø and is provided with special cells for metallurgical work. The design philosophy is described; the building was designed so that further extension is possible in the future. Items described

in some detail are the cell line, gantry transfer, ventilation, services, and construction program. (D.L.C.)

1587 PRIMENENIE RADIOAKTIVNYKH IZOTOPOV DLYA IZUCHENIYA DOLGOVECHNOSTI DETALEI MASHIN. (Applications of Radioisotopes in Engine Wear Studies). A. I. Nisnevich. Moscow, Gosatomizdat, 1962. 184p.

Applications of radioisotopes in lubrication control and wear evaluation are discussed. Tracer analyses are made of lubrication in internal combustion engine transmissions, piston rings, and other engine parts. Safety in handling radioactive materials is also discussed. 222 references are included. (R.V.J.)

1588 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR USE IN HANDLING RADIOACTIVE MATERIALS. Roger Vernon Leicester and William John Lacey Oliphant (to Mitchell Engineering Ltd.). British Patent 908,134. Oct. 17, 1962.

An apparatus is designed for storing and holding a radioactive pencil such as that used in testing pipe welds. The apparatus comprises a shielded container, a pencil holder, and a saddle for holding the pencil and holder during inspection of pipe welds. In operation, the container with pencil and holder is carried to the point of inspection, the recording film and saddle are secured in position on the part to be inspected, and the pencil and holder are transferred from the container to the saddle. (D.L.C.)

1589 IMPROVEMENTS IN OR RELATING TO SEALING DEVICES. Stefan George Bauer and Geoffrey William Duffin (to Rolls-Royce Ltd.). British Patent 908,231. Oct. 17, 1962.

A plugging and sealing device for open-ended bores is designed which may be operated remotely. The device comprises a cylindrical plug body with a series of locking balls for engaging a circumferential channel in the bore, a spring-urged sleeve urging the balls into their locking position, a sealing piece, a plunger, and a toggle mechanism for urging the sealing piece to make the seal. The sealing piece has a coating of a metal, e.g., Ag, Au, or Cd, for deformation to provide a tight sealed fit. (D.L.C.)

1590 IMPROVEMENTS IN OR RELATING TO RADIOLOGICAL IRRADIATION APPLIANCES. Erich Barth and Hans-Ott Jochem (to E. Uhlhorn and Co. Gesellschaft Mit Beschrankter Haftung). British Patent 908,463. Oct. 17, 1962.

An appliance for radiotherapy is designed in which the radiation sources may be easily moved between operative and inoperative (shielded) positions. The appliance comprises a carrier and two supporting members of shielding material; the carrier is mounted for rotation about its axis, and the supporting members are rotatable within the carrier and have recesses for holding radiation sources. A mechanism for rotating the members to and from the operative position is described. (D.L.C.)

1591 IMPROVEMENTS IN METHODS OF MAKING THIN REINFORCED TUBULAR DIAPHRAGMS AND IN DIAPHRAGMS MADE ACCORDING TO THESE METHODS. Pierre Plurien, Maurice Quenault, and Roger Rigot (to Commissariat à l'Énergie Atomique). British Patent 908,480. Oct. 17, 1962.

A process is given for producing thin tubular elements with metallic stiffening ribs for use as diaphragms in isotopic separation by gaseous diffusion. The process comprises taking a metal tube whose outer wall is shaped to provide stiffening ribs, subjecting the inner wall to anodic oxidation until the wall metal between the ribs is completely converted into a metal oxide with the metal of the ribs still intact, and then discontinuing the oxidation. Techniques and tools for forming the ribs are described. (D.L.C.)

1592 IMPROVEMENTS IN OR RELATING TO VARIABLE LENGTH CONDUITS. Jean Verheyden (to Commissariat à l'Énergie Atomique). British Patent 908,532. Oct. 17, 1962.

A helically wound, resilient pipe is designed for taking off liquids of different density in reciprocating vessels such as gyroscopic centrifuges. The helix is provided with means for varying the linear distance between the ends of the helix, so that the lower end can be raised or lowered when the height of the level of the liquid being taken off changes. The helix is adaptable to servo control. (D.L.C.)

1593 IMPROVEMENTS IN ION GENERATORS. William Wesley Hicks and John Collier Beckett (to Ionaire, Inc.). British Patent 908,669. Oct. 24, 1962.

An ion generator for producing light ions of either sign is designed which uses soft beta rays from tritium to ionize air. The ion generator comprises a radioactive source, preferably a tritium foil, used as an electrode, and another electrode spaced from the source electrode. An air flow is set up, with the source shielded therefrom, and charges of opposite voltage are applied to the respective electrodes. As the ions are generated, the desired ions are swept into the air flow. (D.L.C.)

1594 IMPROVEMENTS RELATING TO THE MANUFACTURE OF HOLLOW METAL ENCLOSURE WALLS. Raymond Hugh Attwood and George Albert Barnett (to Associated Electrical Industries Ltd.). British Patent 908,706. Oct. 24, 1962.

An apparatus is designed for supporting a torus sector during maching operations with a rotating tool. The apparatus comprises a longitudinal support member pivoted about one end and adapted to support the torus sector with its axis of curvature coincident with the pivot axis, and screw-jack means for turning the support member to move the torus sector gradually along its equator. The apparatus is suitable for interior and exterior machining of torus sectors for use in toroidal thermonuclear reactors. (D.L.C.)

1595 IMPROVED METHOD FOR PUMPING GASES AT LOW VACUUM PRESSURES. (to U. S. Atomic Energy Commission). British Patent 908,877. Oct. 24, 1962.

A method and an apparatus are described for pumping gases down to pressures as low as 10^{-10} mm Hg. The method comprises establishing a vacuum equilibrium pressure of $\leq 10^{-6}$ mm Hg in a cavity with gettering metal surfaces, subjecting the cavity to pressure bursts to desorb the gettered gases, and removing the desorbed gases with a diffusion pump. (D.L.C.)

1596 COLLIMATOR FOR HIGH ENERGY RADIATION BEAMS. George H. Sharp, André Frenette, and Frederick W. Taggart (to Aviation Electric Ltd.). Canadian Patent 640,052. Apr. 17, 1962.

A collimator for radiation beams in the treatment of living tissue is designed which is adjustable to vary the solid angle without undue distortion of the beam pattern on the target. The collimator comprises an inner and an outer ring of leaves of quantum-absorbing material and means for adjusting the inclination of each leaf and for mounting the outer ring, whereby the gap between any two leaves of the inner ring is covered by a leaf in the outer ring. (D.L.C.)

1597 CORE-SAMPLING APPLIANCE FOR GRAPHITE-TYPE NUCLEAR REACTOR. Roger Cante (to Commissariat à l'Énergie Atomique). Canadian Patent 642,908. June 12, 1962.

An appliance is designed for cutting out cylindrical samples of graphite from the internal wall of a reactor duct.

The appliance comprises an elongated frame for introduction into the duct, a cutting tool carried by the frame and rotatable about an axis perpendicular to the frame and duct axes, a driving motor outside the duct and with a transmission to the tool, and means for breaking off the core sample at its base when cutting is finished. A cooling system is provided for the cutting tool. (D.L.C.)

1598 CLAMPS. René Marmillon (to Commissariat à l'Énergie Atomique). Canadian Patent 644,120. July 3, 1962.

A clamp is designed for positioning and gripping graphite rods or blocks which are to be accurately machined. The clamp comprises two support plates normal to each other, a jaw for each plate, and fluid-operated pistons for moving the jaws. (D.L.C.)

1599 APPARATUS FOR GENERATING THERMONUCLEAR ENERGY BY FUSION OF ATOM NUCLEI. Bo P. Lehnert. Canadian Patent 645,261. July 24, 1962.

An annular current conductor for generating a confining magnetic field is designed with its connection leads shaped so that there is no net field tending to force the leads apart. The leads are caused to follow a divergent path away from the conductor loop, the distance between the leads being equal to $\mu_0 I/2\pi B_0$, where $\mu_0 = 4\pi \times 10^{-7}$, I = current density, and B_0 = magnetic field intensity. Thus, the B_0 at any point in one lead is canceled by a field from the current passing in the other lead. (D.L.C.)

1600 CRYOGENIC METHOD AND APPARATUS FOR IRRADIATION AT LOW TEMPERATURES. Louis Bochirol, Jacques Doulat, and Louis Weil (to Commissariat à l'Énergie Atomique). Canadian Patent 645,594. July 24, 1962.

A cryogenic apparatus for reactor irradiations at low temperatures is designed which recycles a relatively small volume of the cooling liquid, e.g., liquid N_2, and is of reduced dimensions. The apparatus comprises a bath of the cooling liquid in a zone of high radiation flux and a condensation exchanger in a zone of weak flux. The apparatus is particularly suited for use in a swimming-pool reactor. (D.L.C.)

1601 NEUTRON AMPLIFIER. Lyle B. Borst and Paul A. Michael (to Dow Chemical Co.). U. S. Patent 3,056,737. Oct. 2, 1962.

A neutron amplifier of the "Convergatron" type, in which a neutron flux is increased stage by stage by passing through moderator and fuel regions, is designed to reduce the feedback and to increase the transparency to epithermal neutrons in the desired direction. The improvements are obtained by means of discontinuous fuel distribution in the fuel regions, conically shaped cavities in the fuel regions, and modifications of the moderator regions. (D.L.C.)

1602 PORTABLE GENERATOR UTILIZING DIRECT CONVERSION OF HEAT TO ELECTRICITY. Gilbert W. Meyers (to North American Aviation, Inc.). U. S. Patent 3,056,848. Oct. 2, 1962.

A fuel-fired portable generator is designed which has a long lifetime, is resistant to mechanical shock, and can be operated for long periods of time under subzero weather conditions. The generator uses thermoelectric devices to effect the conversion of thermal to electric energy. Gasoline is used as fuel, and the output is 30 watts and 6 volts for 12-hr continuous operation. The lifetime is 1000 hr with 12 hr on-12 hr off cycle. (D.L.C.)

1603 THERMOELECTRIC GENERATOR. Jan Forman (to Burroughs Corp.). U. S. Patent 3,056,912. Oct. 2, 1962.

A thermionic generator is designed which has means for heating the anode (collector electrode) to increase the electron discharge current between the cathode (emitter electrode) and the anode. The anode is heated to a temperature above 400°C but less than 90%, on an absolute temperature scale, of that of the cathode. (D.L.C.)

1604 PHOTOELECTRIC GENERATOR. John H. Coleman (to Radiation Research Corp.). U. S. Patent 3,058,022. Oct. 9, 1962.

A photoelectric generator is designed which functions without an external source of electric power. The collector electrode surfaces have work functions much lower than those of the emitter electrode, so that the contact potential difference between the electrodes accelerates the emitted electrons and thus increases the output power. Several embodiments of the generator are described with different ways of minimizing losses due to electrons emitted by the collector electrode. (D.L.C.)

1605 MOLECULAR BEAM SOURCE. James George (to National Co., Inc.). U. S. Patent 3,058,023. Oct. 9, 1962.

A source is designed for supplying a beam of gaseous cesium for use in a molecular beam frequency standard on an airplane or a missile. The source comprises a reservoir of liquid cesium, a heater for evaporating the cesium, and a collimator for forming the beam. The liquid cesium is held in a mass of packed fibers wetted by cesium, and a nonwettable barrier is provided for allowing the passage of gaseous cesium without any escape of liquid cesium. (D.L.C.)

Heat Transfer and Fluid Flow

1606 (HW-SA-2787) FORCES IN A MOVING BED OF PARTICULATE SOLIDS WITH INTERSTITIAL FLUID FLOW. Herman L. Brandt and Benjamin M. Johnson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 9, 1962. Contract AT(45-1)-1350. 28p.

The radial stress at the wall and the average vertical stress were measured in a moving bed of particulate solids through which a fluid is flowing. Three sizes of ion-exchange resin and 20-50 mesh glass beads were used. Results show that the forces exerted on the bed by the flowing fluid can be treated as an additional body force on the bed as a continuum. The stress variation in countercurrent flow was closely represented by the integrated equation of the force balance on a cross section of the bed. In cocurrent flow the integrated force balance represented the stress variation in only one size of resin; in the other solids, the coefficient of friction at the wall and the radial-to-vertical stress ratio changed with increasing bed depths but reached asymptotic values in deep beds. (auth)

1607 (K-1543) GAS MASS FLOW MEASUREMENTS ACCURATE TO ONE-TENTH PERCENT. E. C. Evans and G. W. Ray (Oak Ridge Gaseous Diffusion Plant, Tenn.). [1961]. Contract [W-7405-eng-26]. 20p.

Analytical and experimental evaluations were made of a gravimetric method for measuring gas mass flows and its application as a laboratory standard. The apparatus and operating procedure are described in detail. Flows of air from 1.0 to 60 grams per minute were measured with an estimated accuracy of better than ±0.1% and a precision of ±0.064% per determination at the 95% confidence level. (auth)

1608 (TID-17049) RATES OF EVAPORATION. Nuclear Reactor Containment Bimonthly Report No. 14. George R. Gavalas (Minnesota. Univ., Minneapolis). Sept. 1962. Contract AT(11-1)-926. 14p.

In a study of the maximum heat transfer rates for forced convective two-phase flow, knowledge of the conditions under which the net evaporation rates from a liquid surface would sustain the heat fluxes in the range of burnout is desirable. The results of an analytical investigation in this area are presented. The theoretical expressions for the evaporation rate from a super-heated liquid surface are based on the kinetic theory of gases and liquids. While the kinetic theory of gases agrees well with experimental results, at least for systems of low pressure, the theories dealing with the behavior of liquids are of an approximate character and cannot be used for predicting physical quantities without resort to experiments. Experimental data concerning evaporation rates are not available except for a range of very low pressures. The evaporative capacity of a liquid surface with a few degrees of superheat is of interest with reference to heat transfer problems. Several procedures are proposed for estimating the evaporation rates of water over a wide range of pressures. The accuracy of the estimations must await experimental investigations. The results of the calculations show that burnout fluxes can be transferred from the liquid surface by evaporation with a minimal amount of liquid superheat. (auth)

1609 (TID-17091) DESIGN SUMMARY REPORT—EXPERIMENTAL TEST LOOP FOR QUALITY REGULATION APPARATUS. Topical Report No. 5. N. A. Radovcich (Dynatech Corp., Cambridge, Mass.). Oct. 1962. Contract AT(30-1)-2907. 23p.

Design criteria and a design summary are presented for a low-pressure air-water test loop. Schematic diagrams of the test loop and the major components together with an equipment list are also included. (auth)

1610 (AEC-tr-5517) AN EXPERIMENTAL INVESTIGATION OF THE CESSATION OF FILM BOILING OF A LIQUID ON A SUBMERGED HEATING SURFACE. V. G. Morozov. Translated from Inzh.-Fiz. Zh., Akad. Nauk Belorussk. SSR, 5: No. 4, 15-19(1962). 7p.

Experimental data are presented concerning the cessation of film boiling in methanol, n-propanol, 95% ethanol and CCl_4 at the surfaces of submerged heating surfaces. Interpretations of the results are given in dimensionless-group form. The results are compared with those obtained by other investigators. (J.R.D.)

1611 (AEC-tr-5518) CRITICAL HEAT FLUXES IN THE FLOW OF A WETTING LIQUID WITH THE ORE [OF THE STREAM] BELOW THE SATURATION TEMPERATURE. S. S. Kutateladze. Translated from Nauchn. Doki. Vysshei Shkoly, Energ., No. 2, 229-39(1959). 11p.

It is noted that there are several conditions and thermodynamic parameters which determine the limiting heat flux at which nucleate boiling is preserved. An analysis of these factors is presented in which the hydrodynamic theory of critical conditions in the mechanism of boiling is used. This hypothesis also serves in the generalization of experimental data for conditions of free convection and for forced flow boiling liquid. (J.R.D.)

1612 (AEC-tr-5519) THE RELATIONSHIPS IN FILM FLOW ON A VERTICAL CYLINDRICAL TUBE. B. S. Kasimov and F. F. Zigmund. Translated from Inzh.-Fiz. Zh., Akad. Nauk Belorussk. SSR, 5: No. 4, 71-4(1962). 6p.

A mathematical substantiation of an experimentally demonstrated phenomenon concerning film flow along vertical tubes is presented. It is shown mathematically that the film thickness increases along the length of the stream. Modifications of equations used in two-phase flow determinations are also described. (J.R.D.)

1613 HEAT TRANSFER BURNOUT IN A STEAM-GENERATING TUBE. V. N. Smolin, V. K. Polyakov, and V. I. Esikov. At. Energ. (USSR), 13: 360-4(Oct. 1962). (In Russian)

Heat transfer burnout was studied during the boiling of water under forced convection in an experimental device consisting of a 10-mm-diam. stainless steel tube with a wall thickness of 1 mm in which the water-steam mixture was circulated. Chemically demineralized water, circulated by means of a pump into an electrical heater, then into the test portion of the device where the steam generation took place, was used as heat transfer agent. The water-steam mixture was sent to the separator whence the separated phases reached the heat exchanger in which the steam was condensed and the water cooled. The tests were carried out under a pressure of 150 atm. at velocities ranging from 850 to 7000 kg/m^2 sec and heat loads of (0.46 to 1.65) $\times 10^6$ $kcal/m^2$ hr. The burnout took place at a well-defined steam content and was revealed by a sudden change of the wall temperature. The tests were terminated when these wall temperature variations amounted to 10 to 15°C. It was found that the weight flow rate of the heat transfer agent exerts an inverse effect on the critical heat loads. Empirical formulas, accurate within ±30%, were derived for determining these critical heat loads. (TTT)

1614 CRITICAL HEAT LOADS DURING THE BOILING OF SATURATED LIQUIDS IN TUBES. R. A. Rybin. At. Energ. (USSR), 13: 377-80(Oct. 1962). (In Russian)

Comparison of theoretical and experimental heat transfer data of various authors indicated that only the consideration of the hydrodynamic factors could lead to the derivation of generalized conclusions. For this reason the dependence of the critical heat load on various criteria in the case of the boiling of a nonviscous liquid in a large volume was examined on the basis of the hydrodynamic theory. Absence of sufficient data prevented consideration of the effect of the tube diameters on the critical heat flux during the flow of water–steam mixtures through the tubes; all the data considered involve tests with tube diameters ranging from 6 to 10 mm. Comparison of the data of the various authors showed a divergence by a factor of 2 to 3, even though parameters such as flow rate, pressure, steam content of the liquid, and the tube diameters were identical. The plotted data indicate that when the steam content at the inlet point was equal to 0, the critical heat load remained constant but introduction of steam–water mixture resulted in an increase of the critical heat load. (TTT)

1615 INVESTIGATION OF THE HEAT TRANSFER TO LIQUID SODIUM IN TUBES. V. I. Subbotin, A. K. Papovyants, P. L. Kirillov, and N. N. Ivanovskii. At. Energ. (USSR), 13: 380-2(Oct. 1962). (In Russian)

Heat transfer tests of Na circulating under steady and turbulent flow conditions in electrically heated tubes were carried out using Cu, carbon steel, stainless steel, and nickel tubes. The oxides were removed from the Na by a cold trap, keeping the O content between 5×10^{-4} and 3×10^{-3} wt.%. The flow rates ranged from 0.065 to 2.17 m/sec at temperatures between 190 and 310°C under a heat load of 18500 to 58000 $kcal/m^2$ sec. The heat transfer coefficients were calculated by the radial temperature distribution in the Na stream and the distribution of the wall temperature alongside the test section and in the liquid in the mixing chamber. Upon decreasing the Peclet (Pe) number, the Nusselt (Nu) number was found to decrease to values below the theoretical ones required by laminar flow; this phenomenon could not be explained on the basis of the contact heat resistance at the wall–liquid boundary. Systematic differences were noted in the average temperatures of

the stream calculated by the two methods, at Pe numbers <200. In the Pe number range from 200 to 1150 the following relationship holds within an accuracy of ±10%: $Nu = 5 + 0.025\ Pe^{0.8}$. The experimental results obtained in low-Pe-number range were below the data reported by other authors with different liquid metal heat transfer agents. The O content of the Na did not exert any noticeable effect. (TTT)

1616 BUBBLE DYNAMICS AT THE SURFACE OF AN EXPONENTIALLY HEATED PLATE. S. G. Bankoff (Northwestern Univ., Evanston, Ill.). Ind. Eng. Chem., Fundamentals, 1: 257-9(Nov. 1962).

The consequences of Zuber's hypothesis, which states that at every instant the latent heat increase of a bubble growing at a heated surface is equal to the superheat energy of the liquid displaced by the bubble, are evaluated for an exponentially heated plate. For a bubble growing in saturated liquid, the radius increases initially as $t^{3/4}$, a result in agreement with Zwick's relationship for a bubble growing in a liquid with exponential volume heat sources. The effect of plate thickness is also discussed. (auth)

1617 NATURAL CONVECTION IN HORIZONTAL CONCENTRIC CYLINDRICAL ANNULI. Lloyd Crawford and Robert Lemlich (Univ. of Cincinnati). Ind. Eng. Chem., Fundamentals, 1: 260-4(Nov. 1962).

The problem of steady, laminar natural convection between horizontal concentric circular cylinders was attacked numerically via detailed difference equation approximations for the differential equations of conservation. No terms were eliminated by boundary layer arguments. The problem was solved with machine language on an IBM 650 digital computer for several diameter ratios and several Grashof numbers at a Prandtl number of 0.714. Computed results agree well with experiments reported in the literature. In the appropriate limiting case, the computed results also accord with an analytical derivation for creeping flow. (auth)

1618 THE EFFECTS OF NUCLEATE BOILING VERSUS FILM BOILING ON HEAT TRANSFER IN POWER BOILER TUBES. H. S. Swenson, J. R. Carver, and G. Szoeke (Babcock and Wilcox Co., Alliance Ohio). J. Eng. Power, 84: 365-71(Oct. 1962).

In large, subcritical pressure, once-through power boilers, heat is transferred to steam and water mixtures ranging in steam quality from zero per cent at the bottom of the furnace to 100 per cent at the top. In order to provide design information for this type of boiler, heat-transfer coefficients for forced convection film boiling were determined for water at 3000 psia flowing upward in a vertical stainless-steel tube, AISI Type 304, having an inside diameter of 0.408 inches and a heated length of 6 feet. Heat fluxes ranged between 90,000 and 180,000 Btu/hr-ft^2 and were obtained by electrical resistance heating of the tube. The operation of the experimental equipment was controlled so that nucleate boiling, transition boiling, and stable film boiling occurred simultaneously in different zones of the tube. The film boiling data were correlated with a modified form of the equation $Nu = a\,a(Re)^m(Pr)^n$ using steam properties evaluated at inside surface temperature. Results of a second series of heat-transfer tests with tubes having a helical rib on the inside surface showed that nucleate boiling could be maintained to much higher steam qualities with that type of tube than with a smooth-bore tube. (auth)

1619 HEAT FLOW IN COMPOSITE SLAB, CYLINDER, AND SPHERE. Walter P. Reid (U. S. Naval Ordnance Lab., White Oak, Md.). J. Franklin Inst., 274: 352-7(Nov. 1962).

A solution is given to a heat-conduction problem in a medium of two layers. The layers are in poor thermal contact; heat is generated in each; their initial temperatures are prescribed functions of distance; and "radiation" boundary conditions are used, with the temperatures of the surroundings varying with the time. Answers are given for the particular cases of slabs, cylinders, and spheres. (auth)

1620 TWO REGIMES OF BURNOUT (DNB) CORRELATED WITH STEAM ENERGY FLOW FOR UNIFORMLY-HEATED CHANNELS. William J. Levendahl (Martin-Marietta Corp., Baltimore). Nucl. Sci. Eng., 14: 201-3 (Oct. 1962).

The scatter in DNB (departure from nucleate boiling) correlations is minimized if the DNB heat flux is plotted vs $G(h-h_f)$, the rate of flow of enthalpy of vaporization across unit flow area or steam energy flow. Two distinct regimes exist in this kind of graph, one associated with thermal instability (DNB-1) and the other with hydrodynamic instability (DNB-2). The characteristics of each regime are discussed in some detail. Most H_2O- and D_2O-cooled reactors operate below the DNB-1 regime, and thus burnout by hydrodynamic instability is much more likely than by thermal instability. (D.L.C.)

1621 MINIMUM MASS THIN FINS WITH INTERNAL HEAT GENERATION. J. Ernest Wilkins, Jr. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Sci. Eng., 14: 203-4(Oct. 1962).

Minimum profile areas are computed using the calculus of variations for both the sharp optimum fin and the triangular fin. The results are plotted as dimensionless minimum profile area and dimensionless fin height vs Λ ($= Qq_0^2/kh^2T_0^3$); they show that the triangular fins are inferior to the optimum fin at small Λ but superior to the optimum fin with constant temperature gradient at large Λ. (D.L.C.)

1622 NON-STATIONARY FLOW OF VISCOUS INCOMPRESSIBLE FLUID. D. V. Sharikadze. Priklad. Mat. i Mekhan., 26: 966-9(Sept.-Oct. 1962). (In Russian)

A problem of nonstationary flow in viscous incompressible fluid between two rotating planes was reduced to a system of integral equations and resolved by a method of consecutive approximations. (R.V.J.)

1623 IMPROVEMENTS IN OR RELATING TO FLUID FLOW CONTROL VALVES. Arthur William Lee and Albert Arthur Hallifax (to United Kingdom Atomic Energy Authority). British Patent 908,170. Oct. 17, 1962.

A fluid flow control valve is designed which gives a wide range of flow rate characteristics and is particularly adapted for automatic operation. The valve comprises a seating part and an adjusting part, each part having a series of tongues spaced apart and arranged so that fluid passes through spaces between the respective tongues of the two parts. An adjustable shutter is provided over the spaces between the tongues of the adjusting part, so that the flow rate characteristics may be varied without interfering with automatic system controls. (D.L.C.)

1624 IMPROVEMENTS IN OR RELATING TO FLOWMETERS. Colin Geoffrey Clayton (to United Kingdom Atomic Energy Authority). British Patent 909,013. Oct. 24, 1962.

A flowmeter for gases is designed which uses a radiation source and detector. The flowmeter comprises a pipe with a hinged vane adapted to be deflected by the fluid flow, a radiation source mounted on the vane, and a radiation detector mounted above the pipe so that the distance between source and detector varies with the vane deflection. (D.L.C.)

Materials Testing

1625 (CEND/2010/RS/58) ULTRASONIC INSPECTION OF TUBE-TO-TUBE JOINTS. D. K. Gourley and C. E. Burdg (Combustion Engineering, Inc. Nuclear Div., Windsor, Conn.). Oct. 28, 1959. Contract AT(30-1)-2379.

Laboratory tests were performed on various transducer configurations. These included both cylindrical and square shapes, at several orientations. Ultrasonic fields in an open tank were measured to establish transducer characteristics; similarly, plots were made of signals obtained in a typical tube bundle. Observation of the received signal was correlated with visual inspection of the tube bundle, in order to determine the significance of the changing signal parameters. In all cases, the technique was one of pulsed transmission. (auth)

1626 (LADC-5354) NONDESTRUCTIVE INSPECTION OF FUEL ELEMENTS FOR NUCLEAR ROCKETS. Gerold H. Tenney (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract [W-7405-eng-36]. 27p.

Some of the contributions nondestructive testing made toward the development of the KIWI-A fuel element are discussed. Radiographic techniques developed for this specific purpose are described. By means of this inspection method, the uniformity of distribution of uranium in the graphite, inclusions, laminations, and other defects were were studied. Radiation gages were used to obtain data on the density distribution. Special ultrasonic inspection techniques were developed for the detection of laminar cracks in fuel plates. (auth)

1627 (TID-17036) NONDESTRUCTIVE DETERMINATION OF IRON IN URANIUM FUEL ELEMENTS. J. W. Colby (National Lead Co. of Ohio, Cincinnati). [1961]. Contract [AT(30-1)-1156]. 13p.

A method and equipment are described for a nondestructive quantitative determination of the Fe content of heat-treated U fuel cores. The test is relatively simple and rapid and will permit checking the Fe content of U fuel cores during production-line inspection. Iron is normally present in as-rolled U as U_6Fe. If as-rolled U is heated into the beta-phase and held for a period of time, the U_6Fe dissolves and forms a solid solution of Fe in U. Rapid quenching retains the Fe in a metastable solid solution, and this in turn causes a small change in electrical resistivity. An eddy-current technique is then employed to detect the resultant change in resistivity. (auth)

1628 MATERIALS TESTING AT CRYOGENIC TEMPERATURES IN A NUCLEAR REACTOR. A. M. Liebschutz (Lockheed-Georgia Co., Dawsonville, Ga.). Preprint Paper No. CP 62-1075. New York, American Institute of Electrical Engineers, 1962. 11p. $1.00

An experimental program is described for determining the mechanical properties of materials at cryogenic temperatures under nuclear reactor irradiation. This program is in three parts, namely, correlation testing, screening testing, and an intensive final test program. (auth)

1629 GAMMADEFEKTOSKOPIE METALLISCHER WERKSTOFFE. (Gamma Defectoscopy of Metal Materials). Guenter Freyer. Leipzig, Veb Deutscher Verlag fur Grundstoffindustrie, 1961. 68p.

The development and significance of nondestructive materials testing are reviewed. The nature and production of energy-rich radiation are discussed. For the use of radiation in testing it is necessary to employ the various phenomena which result from the action of radiation on matter. Techniques of gamma irradiation and gamma detection are described. Economic advantages are discussed. Methods of radiation protection are outlined. (M.C.G.)

1630 SYSTEM FOR TESTING ARTICLES BY VIBRATION. Gordon John Terry (to United Kingdom Atomic Energy Authority). British Patent 908,385. Oct. 17, 1962.

A system for testing the performance of articles or components under conditions of high g is designed which has a low power requirement. The system comprises a rigid load carrier beam mounted at one end on a hinge, a torsion bar for returning the beam to its original position after displacement, means for altering the effective length of the bar, and a vibrator for producing resonance oscillation of the beam. (D.L.C.)

GEOLOGY, MINERALOGY, AND METEOROLOGY

1631 (A/AC.82/G/L.703) ISSLEDOVANIE RADIOAKTIVNYKH ZAGRYAZNENII V RAIONE CHERNOGO MORIYA V 1959 G. (Investigation of Radioactive Contamination in the Black Sea Area in 1959). V. P. Shvedov, A. A. Yuzefovich, L. I. Belyaev, N. I. Popov, L. I. Gedeonov, L. M. Ivanova, N. P. Ushakova, and S. A. Patin (U.S.S.R. Sovet Ministrov. Gosudarstvennyi Komitet po Ispol' zovaniyu Atomnoi Energii). 1961. 28p.

Measurements of atmospheric contamination in the Crimean Simeiz district within ~30 m of the Black Sea water line, during Aug.-Dec. 1959, indicated a considerable purification of the atmosphere. In spite of negligible rain water contamination the fallout level at the monitored Black Sea point remained unchanged. Studies made in the Leningrad district during the same period showed a drop in both atmospheric and soil contamination. The observations indicate a considerable variation in fallout behavior at points remote from sea water that must result from sedimentation factors. Monitoring of fallout during rainy and dry periods in both regions exhibited two types of contamination, one easily washed out by rain and the other not so easily washed out. Tabulated data are given from daily measurements in Simeiz and in Leningrad. The method for measuring Sr^{90} content in the Black Sea is described. (R.V.J.)

1632 (IA-751) EARLY RADIOACTIVE FALLOUT IN ISRAEL FOLLOWING THE 1961 NUCLEAR WEAPON TESTS. J. R. Gat, Y. Feige, N. Pazy, and N. Rosintal (Israel. Atomic Energy Commission, Rehovoth). June 1962. 21p.

Daily samples of airborne and deposited radioactivity were collected in Israel during the months following the 1961 nuclear weapon tests. The age and composition of the fall-out was determined by radiochemical and decay analysis. Meteorological analysis of the data shows that except for one case of direct cross-European transport, the favored path of the early radioactive fallout into the Levant was by a circumpolar route in the upper troposphere. From December 1961 onwards there is evidence for increasing stratospheric contribution to the collected radioactivity. (auth)

1633 (TEI-788) WATER WELLS IN FRENCHMAN AND YUCCA VALLEYS, NEVADA TEST SITE, NYE COUNTY, NEVADA. J. W. Hood (Geological Survey, Washington, D. C.). July 1961. 61p.

Three wells in Frenchman Valley and one well in Yucca Valley are used to supply water at the Nevada Test Site. The pumps were removed from these wells in 1959 to permit the replacement of air lines and the inspection, cleaning, and repair of pumps and casing. Afterward, tests by pumping were made in each well. The yields of the wells range from about 40 gpm to about 160 gpm, and their specific capacities from about 0.7 to 3.7 gpm per ft of drawdown. The coefficients of transmissibility range from about 1,000 gpd per ft at a well in tuff of the Oak Spring formation to about 3,000 gpd per ft, or more, at a well in valley fill. Water levels in the Frenchman Valley wells have declined no more than about 6 ft, as a result of pumping, but the water level in the well in Yucca Valley has declined about 31 ft. Measurements of depth showed that wells in Frenchman Valley had filled from 10 to 16 ft since their construction, but that the well in Yucca Valley had not filled at all. The well water corrodes both well casing and pumps; hence, the use of protective cathodic devices and corrosion-resistant well screen is suggested. The yield of one of the wells might be increased by lowering the pump. The total supply of water probably could be increased by employing more wells, which, however, would not seriously dewater the aquifers. To afford maximum yields, new wells should be as deep and as large in diameter as practicable. Frenchman Valley is especially promising because the aquifer in the vicinity of the present well field is at least 500 ft thick. (auth)

1634 (UCRL-13004) EQUATIONS OF STATE OF GRANITE AND SALT. Final Report. D. R. Grine (Stanford Research Inst. Poulter Labs., Menlo Park, Calif.). May 15, 1961. For Univ. of California Lawrence Radiation Lab., Livermore. Subcontract No. 122. 24p.

The determination of the low-amplitude portions of the Hugoniot equations of state of two rocks, a quartz monzonite porphyryl (granite) and rock salt, is described. In the experiments the shock-wave velocity and the free-surface velocity produced on reflection of the shock from a free boundary were measured. These, together with a relation between free-surface velocity and particle velocity prior to reflection, are sufficient to determine the stress-density-energy state behind the shock wave. A series of measurements with different shock intensities thus determines the Hugoniot equation of state, or locus of states attainable through a single shock transition. (M.C.G.)

1635 THE ABSOLUTE MEASUREMENT OF THE RADIOACTIVE PRECIPITATIONS. E. Guilino and K. Stierstadt (Universität, Munich). Atomkernenergie, 7: 241-8(July-Aug. 1962). (In German)

On the basis of comparative measurements of the radioactivity of precipitations made over a long time period and of residual masses collected in various types of vessels, statements on the reliability of such measurements are given with reference to the statistical and systematic deviations in the results. The statistical uncertainty of the measurement data is inversely proportional to the root of the surface area of the collection vessel. The placement of a collector disturbs the natural conditions; therefore there is a dependency of the measurement values on the construction units of the collector. The dependence of the mutual deviation on weather factors, especially wind velocity, is investigated. Plausible assumptions on the separation processes of the various types of collectors lead to a qualitative, partly semi-quantitative, understanding of the mutual deviations in the data. The dependency of the measurement values on the location of the collector is essentially based on the variation of the amounts of rain at the different sites. (tr-auth)

1636 TUNGSTEN ABUNDANCES IN METEORITIC AND TERRESTRIAL MATERIALS. A. Amiruddin and W. D. Ehmann (Univ. of Kentucky, Lexington). Geochim. Cosmochim. Acta, 26: 1011-22(Oct. 1962).

The abundances of tungsten in 17 chondrites, 6 achondrites, 5 siderites, one sample of meteoritic olivine, one sample of meteoritic troilite, 5 types of tektites, one meteoritic impact glass, 3 obsidians, 4 samples of a deep-sea sediment core, and 2 standard rocks were determined by means of neutron activation analysis. A cosmic atomic abundance for tungsten of 0.11 ($Si = 10^6$) was calculated on the basis of the chondrite analyses. Information on the geochemical distribution of tungsten in separated meteoritic

phases and certain terrestrial rocks was obtained. Some implications of the data of theories of nucleosynthesis and meteorite formation are discussed. (auth)

1637 POSSIBLE Zr–Hf FRACTION BETWEEN EARTH AND METEORITES. L. H. Ahrens (Univ. of Cape Town). Geochim. Cosmochim. Acta, 26: 1077-9(Oct. 1962).

Discussion is given on the fractionation of Zr–Hf between common terrestrial rocks and meteorites. Data on Hf and Zr in chondrites and zircons from basic rocks are tabulated as Zr/Hf ratios. Although firm conclusions about the Zr–Hf coherence cannot be made until additional data are obtained, it is concluded that radioactive processes have not significantly altered the Zr/Hf ratio. (P.C.H.)

1638 GEOPHYSICAL DATA ON THE CLIMAX STOCK. NEVADA TEST SITE, NYE COUNTY, NEVADA. John W. Allingham and Isidore Zietz (U. S. Geological Survey, Washington, D. C.). Geophysics, 27: 599-610(Oct. 1962). (TEI-794)

A granitic stock at Oak Spring, Nevada, was selected as a possible site to study the seismic effect of a deep nuclear shot contained in a large volume of rock. Geophysical surveys were conducted to determine the general configuration of the stock, particularly the thickness. The stock intrudes a sequence of carbonate and siliceous sedimentary rocks of Paleozoic age, which are overlain by Tertiary pyroclastic rocks consisting of tuff, welded tuff, and breccia. A three-dimensional analysis of a detailed aeromagnetic survey indicated that the stock has a shape similar to a truncated cone, the diameter of which increases from about one mile at the surface to at least 6 miles near sea level, 5000 feet beneath the surface. The stock, therefore, is much larger than indicated by the area of $1\frac{1}{3}$ square miles exposed at the surface. In addition, computations showed that the intrusion has a thickness of at least 13000 ft. Much of the ambiguity of interpretation was removed from the analysis because susceptibility measurements of cores from recent drilling and remanent magnetization data from surface samples were available. Interpretation of a gravity profile over the stock gave the probable thickness of the overlying alluvial fill and buried tuff, but did not delineate the intrusive from the Paleozoic rocks. (auth)

1639 THE EFFECT OF NUCLEAR EXPLOSIONS ON ATMOSPHERIC ELECTRICITY. Antal Simon. Idojaras, 66: 146-53(May-June 1962).

The distribution of atmospheric radioactivity on a worldwide scale, and the ionizing effect of radioactive fallout accumulated near the ground were investigated and in connection with a series of measurements carried out in Belgium, the effect of radioactive clouds on atmospheric electricity was surveyed. It is concluded that artificial radioactivity will, for a long period after the termination of the experimental nuclear explosions, affect the electric state of the atmosphere. (auth)

1640 TRANSPORT EFFECTS ON THE DISTRIBUTION OF SLOWING-DOWN NEUTRONS AND PULSED NEUTRON WELL LOGGING. V. F. Zakharchenko (Inst. of Geophysics, Urals Division of the Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Geofiz., No. 10, 1357-67(Oct. 1962). (In Russian)

A system of differential equations were obtained in diffusion-transport approximations for the non-stationary problem of slowing-down neutrons. The effects of transport on the distribution of slowing-down neutrons were also investigated in the same approximation. Effects of increased logging depth and the sensitivity of the instrumentation in drill holes are discussed. (tr-auth)

1641 TIDES OF THE NATURAL RADIOACTIVITY OF THE ATMOSPHERE. B. Hess (Physikalischen Institut der Phil.-theol. Hochschule Regensburg, Ger.). Nukleonik, 4: 268-9(Aug. 1962). (In German)

Atmospheric radioactivity was continuously measured in Regensburg for a period of two years. The activity was strongly affected by meteorological factors such as rain, mist, and wind. The periodic variation of the activity in relation to the progress of the tide-producing forces is reported. The results of the mean daily value with respect to gravitational forces, sun and moon, and periodic variation are shown graphically. (J.S.R.)

1642 TROPOSPHERIC PHENOMENA AND LARGE-SCALE DIFFUSION FOUND FROM RADIOACTIVE TRACING. Giorgio Fea and Adriano Gazzola. Riv. Meteorol. Aeronaut., 21: No. 4, 22-8(1961). (In Italian)

Some results of studies carried out by the Italian Air Force Weather Service on tropospheric phenomena of large-scale diffusion and transfer of fission products, injected into the atmosphere as a consequence of the first Sahara nuclear blast, are presented. These results are then compared with those obtained by a similar study carried out by the German Weather Service, and the more important disagreements in interpretation are discussed. (tr-auth)

1643 NEW RESULTS OF ALPINE AIR RADIOACTIVITY MEASUREMENT. R. Reiter (Universität, Munich). Zentr. Briol Aerosol Forsch., No. 3-4, 195-219(Dec. 1960). (In German)

The time pattern of natural and artificial radioactivity and the air impurities in the year 1959 at a valley and at a neighboring mountain station were represented and described using various diagrams. It was shown that the air layer near the ground was fed more long-lived radioactive substances by repeated eddying of the ground than from greater heights. The daily pattern of components of the air radioactivity at the mountain and valley stations were described. The effect of the vertical temperature gradient on the vertical distribution of natural and artificial radioactive substances was thoroughly studied. Conclusions on the half-value height of the natural radioactive elements and therefore on the velocity of the vertical material exchange were given. The application to the estimation of the transport velocity of contaminated particles from heights to the valley was described. From the vertical concentration variation of RaB the exchange coefficient was calculated as a function of temperature stratification. By means of diagrams the correlation between natural or artificial air radioactivity and the relative humidity was described. Whereas natural radioactive particles are bound to the large aerosols of the valley air, this is not valid for the artificial radioisotopes. These were brought up to the mountain station by atmospheric motions. The activity values occurring in the passage of an active cloud from the French atomic explosions in the Sahara were described using motion diagrams. (tr-auth)

1644 GEOLOGIYA I GENETICHESKIE TIPY PROMYSHLENNYKH MESTOROZHDENII URANA. (Geology and Genetic Types of Commercial Uranium Deposits). V. N. Kotlyar (Kotlyarov). Moscow, State Publishing House of Scientific and Technical Literature on Geology and Preservation of Natural Resources, 1961. 246p.

Various aspects of uranium geology and prospecting are discussed. 85 references are included. (R.V.J.)

1645 SHORT PAPERS IN GEOLOGY AND HYDROLOGY, ARTICLES 60-119. GEOLOGICAL SURVEY RESEARCH 1962. (Geological Survey, Washington, D. C.).

Geological Survey Professional Paper 450-C. 1962. 152p. (GPO).

Sixty short papers are presented that report on the scientific and economic results of current work in the fields of geology, hydrology, and related sciences. Separate abstracts have been prepared for 11 selected papers. (C.H.)

1646 A RARE SODIUM NIOBATE MINERAL FROM COLORADO. Raymond L. Parker, John W. Adams, and Fred A. Hildebrand. U. S. Geol. Survey. Profess. Papers, No. 450-C, C4-6(1962).

A rare sodium niobate mineral with Perovskite-type structures was found at Gem Park, Fremont Co., Colo. Identification of the mineral was made by comparison of its x-ray powder data with data of the mineral from the Republic of the Congo. This is the first reported occurrence of sodium niobate mineral in the U. S., and appears to be the third known occurrence in the world. (C.H.)

1647 LOCALIZATION OF THE URAVAN MINERAL BELT BY SEDIMENTATION. Daniel R. Shawe. U. S. Geol. Survey. Profess. Papers, No. 450-C, C6-8(1962).

Uranium–vanadium deposits were localized in the Uravan mineral belt at least partly by favorable lithology in the Salt Wash Member of the Morrison Formation of Late Jurassic age. The Uravan mineral belt is an arcuate zone about 75 mi long in western Colorado and eastern Utah. The belt is characterized by abundant closely spaced deposits and ore bodies within the sandstone layers show a striking radial orientation through the arc of the belt, reflecting a similar orientation of sedimentary structures. In order to determine the amount and location of structural modification of the Salt Wash, an isopach map of an idealized alluvial fan or apron was constructed by using the general configuration of the actual fan. Isopach maps of the actual and idealized fan are presented. It appears that subsidence of the large basin could have caused the development of a lobe or smaller alluvial fan upon the much larger apron of the Salt Wash Member. The formation and geological features of the area are described in detail. (C.H.)

1648 BEACH PLACERS CONTAINING RADIOACTIVE MINERALS, BAY OF BENGAL, EAST PAKISTAN. Robert G. Schmidt and S. Ali Asad. U. S. Geol. Survey. Profess. Papers, No. 450-C, C12-14(1962).

Beach placers containing monazite, ilmenite, zircon, and other heavy minerals extend 100 mi southeastward along the Bay of Bengal from Chittagong to the Burma border. The placers were first noted in 1960. A comprehensive survey of the placers, including an airborne radiometric survey of the entire beach, was begun in 1961 and is continuing. The placers consist of sands generally containing 10 to 30% heavy minerals with local lenses that contain as much as 96% of minerals exceeding 2.80 specific gravity. The principal placers are at 10 localities, with small concentrations of heavy minerals present at many places. Each placer is tens to hundreds of feet wide and several hundreds to thousands of feet long, with at least one extending for several miles. The heavy minerals are in layers from one to 2.5 ft thick. It is postulated that the placer layers were formed by wave action, perhaps during periods of erosion of the beach. The characteristics and location of the placers are described. The mineral suite from beach placers that contain 10 to 30% poorly sorted heavy minerals is described. (C.H.)

1649 POSSIBLE ENGINEERING USES OF SUBSIDENCE INDUCED BY CONTAINED UNDERGROUND NUCLEAR EXPLOSIONS. F. N. Houser and Edwin B. Eckel. U. S. Geol. Survey. Profess. Papers, No. 450-C, C17-18 (1962).

Nearly circular depressions have been formed in the level floor of Yucca Flats, Nevada Test Site, by subsidence over the sites of several of the recent underground nuclear tests. Possible applications are discussed of this method of creating depressions, or sinks, in the creation of harbors or for the preconsolidation of alluvium of construction sites for heavy buildings. Mechanisms involved in creation of the sinks are discussed. It is pointed out that this method is free of radioactive debris and can be used much closer to populated regions than was previously thought possible. (C.H.)

1650 OAK SPRING GROUP OF THE NEVADA TEST SITE AND VICINITY, NEVADA. F. G. Poole and F. A. McKeown. U. S. Geol. Survey. Profess. Papers, No. 450-C, C-60-2(1962).

Recent mapping of the Nevada Test Site has resulted in the Oak Spring Formation, in the northern part of the test site, being raised to the rank of group and the two formations comprising it being named Indian Trail and Piapi Canyon. The geological features of the area are discussed in detail. (C.H.)

1651 LEAD-ALPHA AGES OF ZIRCON FROM NORTH AND SOUTH CAROLINA. W. C. Overstreet, Thomas W. Stern, Charles Annell, and Harold Westley. U. S. Geol. Survey. Profess. Papers, No. 450-C, C81(1962).

Lead-alpha age determinations are reported for zircon from North and South Carolina. Good agreement was found with previous determinations on the same samples. Data are presented on new samples of zircon crystal and the lead-alpha ages determined for them are tabulated. (C.H.)

1652 GEOCHEMICAL FIELD METHOD FOR BERYLLIUM PROSPECTING. L. E. Patten and F. N. Ward. U. S. Geol. Survey. Profess. Papers, No. 450-C, C103-4(1962).

A quick, reliable analytical method is described for determining Be in soils and rocks. The procedure is suitable for determining from 1 to 100 ppm of Be in the sample, but with proper adjustment of the sample size or volume of solution taken for analysis, the range is expandable. The fluorescent complex formed by the reaction of Be with morin (3,5,7,2′,4′-pentahydroxyflavone) is used as a basis for Be determinations in the presence of a suitable buffer and chelating agent. Estimate of Be content of the sample is made by comparing its fluorescence with that of a series of standard solutions. The method is recommended for field use. (C.H.)

1653 INTERBASIN MOVEMENT OF GROUND WATER AT THE NEVADA TEST SITE, NEVADA. Isaac J. Winograd. U. S. Geol. Survey. Profess. Papers, No. 450-C, C108-11(1962). (TEI-807)

Analysis of data from test wells and a configuration of the piezometric surface indicates that the movement of ground water in the valley fill and the tuffs beneath the bolsons of the Nevada Test Site is vertically downward into the Paleozoic carbonate rocks. The ground water moves laterally in the carbonate rocks, though probably circuitously, beneath all three major basins toward discharge areas, presumably to the southwest. (C.H.)

1654 POTENTIAL AQUIFERS IN CARBONATE ROCKS, NEVADA TEST SITE, NEVADA. Stuart L. Schoff and Isaac J. Winograd. U. S. Geol. Survey. Profess. Papers, No. 450-C, C111-13(1962).

Descriptions are presented of two core holes drilled in carbonate rocks in the northern part of Yucca Flat, Nevada Test Site. The core-hole records give some indication of the permeability of the carbonate rocks penetrated, and data from a pumping test of a well in the southern part of Yucca Flat give further information. It is concluded that

the Pogonip Group and the undifferentiated Devil's Gate and Nevada Formations, together with the unidentified limestone in well C, may be aquifers worth further exploration. (C.H.)

1655 HYDROLOGY OF RADIOACTIVE WASTE DISPOSAL IN THE MTR-ETR AREA, NATIONAL REACTOR TESTING STATION, IDAHO. Paul H. Jones and Eugene Shuter. U. S. Geol. Survey. Profess. Papers, No. 450-C, C113-16(1962).

Aqueous low-level radioactive waste of the materials Testing Reactor and Engineering Test Reactor at the National Reactor Testing Station has been discharged to a leaching pond since operations began in 1952. The annual discharge of radioactivity, excluding tritium, has averaged about 3,700 C in about 220 million gallons of water since 1957. The waste discharged has included 40 to 60 radioactive isotopes, about 90% of which have a half-life of less than 100 days. Measurements were made on the tritium content and temperature of waste water and of perched water underlying the alluvium of the Big Lost River at various distances from the disposal pond. The tritium content and temperature of the perched water were found to decrease with distance from the pond except southeastward. Possible explanations are discussed. (C.H.)

1656 VADOSE FLOW IN LAYERED AND NONLAYERED MATERIALS. W. N. Palmquist, Jr. and A. I. Johnson. U. S. Geol. Survey. Profess. Papers, No. 450-C, C142-3(1962).

Studies of downward flow of water were made in two models of porous media to demonstrate the general patterns of flow and the volumes of material wetted beneath disposal pits for nuclear waste. The results indicate qualitatively that pits can be operated more safely where the underlying granular materials are highly stratified and have different grain sizes. The results apply chiefly in arid regions where the deposits above the water table contain very little moisture to great depths and to disposal pits in which the distance across the pit surface is only a few tens of feet. (C.H.)

HEALTH AND SAFETY

1657 (LADC-5501) PROBLEMS ASSOCIATED WITH A HIGH ENERGY X-RAY MACHINE. Donald A. McKown (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract [W-7405-eng-36]. 14p.

Health physics problems associated with the Pulsed High Energy Radiographic Machine Emitting X-rays (PHERMEX), a triple cavity accelerator for producing bremsstrahlung to investigate dynamic systems by radiographic and other techniques, are discussed. Results show that photographic film and Victoreen thimble chambers are sufficient for monitoring radiation around the machine. Thermoluminescent devices also show promise for dosimetry at PHERMEX dose rates. (N.W.R.)

1658 (NDL-TR-33) SIMPLE DECONTAMINATION OF RESIDENTIAL AREAS — McCOY-III. J. C. Maloney and J. L. Meredith (Army Chemical Corps Nuclear Defense Lab., Army Chemical Center, Md.). Sept. 1962. 97p.

The effectiveness achieved, the effort required, and the dose received by personnel in the use of simple decontamination procedures for the radiological recovery of residential areas was investigated. Fall-out simulant was prepared by tagging 150μ to 300μ sand with lanthanum-140. The simulant was dispersed onto lawns, paved areas, and roofs. Decontamination techniques using household and garden tools were evaluated. In addition, the radiological recovery of a small residence and surrounding lawn was effected. (auth)

1659 (AEC-tr-5455) DECONTAMINATION TECHNIQUE FOR STRONGLY RADIOACTIVE WATER USED BY ISOLATED CONSUMERS. Jean Bourrier, Pierre Bovard, and André Grauby. Translated from Compt. Rend. Acad. Agr. France, 48: 40-4(1962). 8p.

An emergency decontamination technique is presented for drinking water when families find it necessary to obtain water from sources contaminated by radioactivity. The method consists of passing the water through a mass of earth packed into a simple pail with the bottom lined with cloth and perforated at several points to allow the water to escape. A decontamination factor of an order of magnitude of 100 was obtained in a series of experiments using mixed fission products. Three liters of water per day were passed through each pail containing 12 kg of earth. It is pointed out that the soil type will affect the absorption of fission products and that I^{131} is poorly absorbed by soil. The soil should be taken from below the surface and the radioactive decontamination of the water should be complemented by biological purification. Precautions should also be taken in disposing of the earth to avoid the risk of contamination of other water by the concentrated fission products. (C.H.)

1660 (JPRS-15920) HYGIENE AND SANITATION. Translation of Gigiena i Sanitariya, 27: No. 7, 8-11; 22-7; 33-42; 60-3; 79-87; 103-5(July 1962). 47p.

A translation of selected articles from Gigiyena i Sanitariya (Hygiene and Sanitation) is presented. Topics covered include: the effects of simultaneous chronic administration of radioactive strontium and the trace element fluorine on hemopoiesis in rats; the application of thermoelectrometry to research in hygiene; determination and continuous recording of the aerosol content of short-lived radioisotopes in air by the filter saturation method; problems of space hygiene; some methodological approaches to hygienic evaluation of the action of environmental factors on the body; and the problem of radioactivity of the soil. Separate abstracts were prepared for three of the papers. (M.C.G.)

1661 (JPRS-15920(p.1-5)) THE EFFECT OF THE SIMULTANEOUS CHRONIC ADMINISTRATION OF RADIOACTIVE STRONTIUM AND THE TRACE ELEMENT FLUORINE ON HEMATOPOIESIS IN RATS. V. A. Knizhnikov and Yu. D. Balika. Translated from Gigiena i Sanit., 27: No. 7, 8-11(July 1962).

Studies were made of the influence of different fluorine concentrations in drinking water on hemopoiesis as well as the combined effect of fluorine and Sr^{90} on bone marrow. The study was made on 62 growing white rats. The consumption of water containing 1.5 mg/l of fluorine by rats for $4\frac{1}{2}$ months did not cause any harmful changes in the bone marrow or peripheral blood according to the indices studied. The consumption of water containing 15 mg/l of fluorine led to a certain reduction in the young forms of the white series in the bone marrow. The combined administration of fluorine and Sr^{90} for two months did not show a summational effect or potentiation. Conversely, with simultaneous administration of Sr^{90} and water containing 1.5 mg/l of fluorine the condition of the bone marrow was somewhat better than in the group of animals given Sr^{90} without the fluorine. (M.C.G.)

1662 (JPRS-15920(p.13-25)) DETERMINATION AND CONTINUOUS RECORDING OF THE AEROSOL CONTENT OF SHORT-LIVED RADIOACTIVE ISOTOPES IN AIR BY THE "FILTER SATURATION" METHOD. S. P. Golenetskii (Golenetskiy). Translated from Gigiena i Sanit., 27: No. 7, 33-42(July 1962).

The method of determining short-lived radioactive aerosols by measuring the filter activity during prolonged continuous passage of the air being investigated through it was analyzed and substantiated. It was shown that in this case the activity of the filter is directly proportional to the concentration of the isotope being determined in the aerosol phase. The method assures the maximum possible sensitivity and accuracy in determinations of short-lived radioactive aerosols. The mathematical treatment of the results was considerably simplified, and introduction of a corrective factor for decay of the sample during the course of sampling and measuring is unnecessary. The method makes it possible to record the radioactive aerosols continuously and automatically and permits solution of the problem of the spectral composition of the radiation of the isotopes being determined in the aerosol phase. (M.C.G.)

1663 (JPRS-15920(42-6)) THE PROBLEM OF RADIOACTIVITY OF THE SOIL (SECOND COMMUNICATION). V. N. Gus'kova and A. N. Bragina. Translated from Gigiena i Sanit., 27: No. 7, 103-5(July 1962).

Data are presented on the total beta activity as well as on the chemical and radiochemical analyses of soils. The samples were selected in monolithic chunks at a depth of 5 cm. On the basis of an analysis of 193 samples, the total natural radioactivity amounted to 0.166 to 3.5 c/km^2. The K^{40} activity amounted to 3×10^{-9} to 1.8×10^{-6} c/kg. The radioactivity of the grass varied within the limits of 2×10^{-9} to 7×10^{-8}. The average was 1.4×10^{-8}. About 60% of all samples of plant roots showed radioactivity from 1×10^{-9} to 3×10^{-8}. (M.C.G.)

1664 RADIOACTIVE FALLOUT DURING PRECIPITATION (SNOWFALL). Yu. V. Novikov, V. A. Liperovskii,

and A. A. Polynkova. At. Energ. (USSR), 13: 385-7(Oct. 1962). (In Russian)

Determination of the radioactive contamination of snow may be used for estimating the rate of removal of radioactive materials from the atmosphere. For this reason studies were carried out during the end of the 1959-60 winter season, correlating the activity values with the time of precipitation. The samples were subdivided into horizontal layers according to the date of snowfall, however, without making corrections for the amount of activity that may be carried to the lower layers by the melting snow. The activity A was calculated from the expression $A = [4.5\ N\lambda(t_n - t_{meas})\lambda]/[KS\Delta t_n]$ where N = counting rate, t_n = date of precipitation of the n-th layer, t_{meas} = date of the measurement, λ = decay constant (defined as $0.693/T_{avg}$ where T_{avg} = average half life of the fission fragments), K = recording efficiency of the β radiation, S = surface area, and Δt_n = period of precipitation of the n-th layer. Different correlations were found between the intensity of the radioactive fallout containing the solid phase and the level of snowfall in the city and suburban areas; in the city an additional 0.06 microcurie/km^2 mm was noted. (TTT)

1665 THE PROBLEM OF THE RELATIVE BIOLOGICAL EFFICIENCY OF VARIOUS TYPES OF RADIATION UNDER CHRONIC EXPOSURE. U. Hagen (Universität Freiburg i. B.). Atomkernenergie, 7: 275-83(July-Aug. 1962). (In German)

For the calculation of the "rem-doses" of a certain type of radiation, it is necessary to know its relative biological efficiency (RBE) to γ rays. The RBE of dense ionizing radiation, especially neutrons, has very often been measured after acute exposures; comprehensive experiments about RBE values after chronic radiation exposure have been published only during the last years. A survey on these experiments is given, to provide a basis for the determination of the RBE values for the radioprotection of men. This summary mainly deals with the effect of neutrons. The RBE values of neutrons are normally not higher than 5 for acute effects on animals. Also, the RBE of neutrons for the late effects after a single exposure is not much higher, i.e., shortening of life span, lens opacities, carcinogenesis and damages in fertility. The RBE values for somatic effects of irradiation after fractionated or chronic exposure are also described. By fractionation the RBE of neutrons is increased up to 15. These high RBE values are due to the fact, that the effects of γ rays are mostly reversible, whereas the effects of neutrons are mostly irreversible. Further, the recovery rate from neutron effects is lower than from the effects of γ rays. Theoretical considerations show, that the RBE of neutrons is doubled, if neutron radiation is given in fractionated exposure as compared to single exposure. For cytological radiation effects, for instance, mitotic delay or chromosome aberrations, much higher RBE values are reported. However the results reported on by different authors vary a great deal. To consider the RBE of neutrons for genetic effects, it is necessary to distinguish between the dominant lethal mutations caused by chromosome aberrations and the recessive point mutations. For the dominant lethals RBE values of neutrons are reported between 4 and 6 and for the recessive lethals between 1 and 2. For other recessive point-mutations, no reliable RBE values are reported. The variability of RBE values under different experimental conditions is shown. (auth)

1666 LABORATORY MONITORING IN THE PEACEFUL APPLICATION OF NUCLEAR ENERGY. Mario Panaccione. Calore, 33: 49-57(Feb. 1962). (In Italian)

The peaceful utilization of nuclear energy has brought problems of safety and security. As an introduction to a consideration of these problems, the difference between nuclear explosions and controlled reactions is described. The limitations on security and protection efficiency are given, and radiation levels with the possible shielding conditions are discussed. The legislative enactments controlling nuclear energy are briefly indicated. Diverse opinions regarding the dangers of various radiation levels are reviewed. (J.S.R.)

1667 IONIZING RADIATION — A MEDICAL PROBLEM. D. Harold Copp (Univ. of British Columbia, Vancouver). Can. Med. Assoc. J., 86: 517-21(Mar. 24, 1962).

Effects of radiation in man, safety standards, and sources of radiation in the environment are reviewed. Recommendations for safety in diagnostic radiologic procedures as proposed by the Adrian Committee are discussed. (H.H.D.)

1668 METHODS FOR THE CONTROL OF LOW MASSES OF RADIONUCLIDES IN WATER. D. Schoenberg (Institut für Angewandte Isotopenforschung, Berlin). (Isotopen Tech., 2: 213-15(July 1962). (In German)

Methods known at the present for the control of low amounts of radioisotopes in water are described, and references to the original literature are given. (tr-auth)

1669 THE PLACE OF WATER ORGANISMS IN RELATION TO RADIATION PROTECTION PROBLEMS IN THE VICINITY OF NUCLEAR ENERGY PLANTS. Roland Glaser (VEB Entwicklung und Projektierung Kerntechnischer Anlagen, Berlin and Institut für Angewandte Isotopenforschung der DAdW, Berlin). Kernenergie, 5: 515-33(July 1962). (In German)

The decontamination of waters by concentrating radioisotopes with marine organisms was studied in a bibliographic survey. The enrichment principles are described with consideration of the mechanism of direct enrichment, dependence of enrichment on various factors, and indirect incorporation. The use of water organisms as indicators in radiological monitoring of waters is also discussed. 94 references. (J.S.R.)

1670 THE VALUE OF FREQUENT REALISTIC EXERCISES IN DISASTER CONTROL. Robert S. Brua and Robert M. Allman (U. S. Air Force, San Francisco). Military Med., 127: 505-8(June 1962).

Training exercises to improve the capability of medical personnel to handle mass casualties are discussed. (H.H.D.)

1671 THE MEDICAL CONSEQUENCES OF THERMONUCLEAR WAR. I. HUMAN AND ECOLOGIC EFFECTS IN MASSACHUSETTS OF AN ASSUMED THERMONUCLEAR ATTACK ON THE UNITED STATES. Frank R. Ervin, John B. Glazier, Saul Aronow, David Nathan, Robert Coleman, Nicholas Avery, Stephen Shohet, and Cavin Leeman (Harvard Medical School, Boston). New Engl. J. Med., 266: 1127-37(May 31, 1962).

An examination is made of the short-term human and ecological consequences in Massachusetts, and in particular in metropolitan Boston, of the limited thermonuclear attack on the United States postulated by the Holifield Committee report of 1959. This assigns 10 weapons totaling 56 megatons to Massachusetts. Damage would result from blast, heat, and radioactive fallout. A 20-megaton ground burst on downtown Boston would seriously damage reinforced-concrete buildings to a distance of 10 miles and demolish all other structures. Within a circle of a radius of 16 to 21 miles second-degree burns would be produced, and clothing, houses, foliage, gasoline and so forth would ignite, producing a fire storm. Human survival in this area would be

practically impossible, and an estimated 2,250,000 deaths would occur in metropolitan Boston from blast and heat alone. Beyond the area consumed by fire, many persons would be exposed to lethal doses of radiation from local fallout. For some of these persons, fallout shelters could reduce the cumulative dose of radioactivity to levels compatible with survival. Many sheltered survivors would be subject to acute radiation sickness and to the long-term somatic and genetic effects of radiation. The similarity of presenting symptoms in persons who had been lethally irradiated and those who had received much smaller doses would create major diagnostic problems in the postattack period. Sublethal irradiation would increase the morbidity and mortality from pre-existing disease and from blast injuries, burns, and infections. Serious ecological problems would result from thermal destruction of forests and widespread lethal irradiation of mammals and birds, accompanied by relative sparing of bacteria, fungi, viruses, and insects, all of which are highly resistant to radiation. (H.H.D.)

1672 THE MEDICAL CONSEQUENCES OF THERMONUCLEAR WAR. II. THE PHYSICIAN'S ROLE IN THE POSTATTACK PERIOD. Victor W. Sidel, H. Jack Geiger, and Bernard Lown (Harvard Medical School, Boston). New Engl. J. Med., 266: 1137-45(May 31, 1962).

The medical consequences in Massachusetts of a 1446-megaton thermonuclear attack on the United States are analyzed. Of 6560 physicians in the Boston metropolitan area, approximately 900 functioning physicians would remain; of the 9440 in the Commonwealth as a whole, 2400 would still be available. The resultant injured-to-physician ratio would be over 1000 to 1; the total patient-to-physician ratio would be much greater. Of 65,000 hospital beds in the Commonwealth, 10,000 would remain to serve their present occupants in addition to 2,000,000 injured. Medical supplies would be inadequate, and competition by survivors for the remaining facilities and supplies would be likely to raise new problems. These quantitative increases in medical needs would lead to qualitative changes in the type of medicine practiced. Some of the problems to be expected in the care of the individual patient, in public-health measures and in decisions of an ethical nature are examined in detail. (H.H.D.)

1673 THE MEDICAL CONSEQUENCES OF THERMONUCLEAR WAR. III. A GLOSSARY OF RADIATION TERMINOLOGY. Saul Aronow (Harvard Medical School, Boston). New Engl. J. Med., 266: 1145-9(May 31, 1962).

Terms used in radiation physics are defined and explained in language intelligible to the layman and physicians. Effects of various doses of radiation on humans are discussed. (H.H.D.)

1674 THE MEDICAL CONSEQUENCES OF THERMONUCLEAR WAR. IV. SOME PSYCHIATRIC AND SOCIAL ASPECTS OF THE DEFENSE-SHELTER PROGRAM. P. Herbert Leiderman and Jack H. Mendelson (Harvard Medical School, Boston). New Engl. J. Med., 266: 1149-55 (May 31, 1962).

Clinical and research experience are applied to some of the psychological and social aspects of the current defense-shelter program to help physicians to advise their patients and plan for their own and their communities survival. Two major issues are discussed: the psychological impact on the individual and community in planning for a defense-shelter program; and the psychological and social problems related to shelter utilization in the event of a nuclear holocaust. Data from studies of relatively limited disasters are used to help physicians understand present reactions and perhaps to predict future behavior. In particular, emphasis is made of the differences between acute, relatively short-term stress and chronic, prolonged stress. The evidence presented indicates that for an untrained, unselected urban population, a shelter permitting the group to carry on some of its usual activities would probably maximize adaptive behavior. It would permit some of the same type of differentiation of function that exists in preshelter society. Physical and psychological illnesses, which would almost certainly exist in some members of the group, would not appreciably interfere with the survival of the group. Dissolution of the family unit would unquestionably have severe psychological consequences, and community shelters that permit some family members to remain together would be most desirable. (H.H.D.)

1675 A RESUME OF ROENTGENOLOGY: THE HENRY CLINE FIXOTT, SR., MEMORIAL LECTURE. LeRoy M. Ennis (Univ. of Pennsylvania School of Dentistry, Philadelphia). Oral Surg., Oral Med., Oral Pathol., 15: 680-92(June 1962).

The development of radiologic diagnostic procedures in dentistry is discussed from an historical viewpoint, including the recognition of hazards and the institution of safety measures. (H.H.D.)

1676 PROPERTIES AND EVALUATION OF RADIOACTIVE ATMOSPHERIC IMPURITIES. W. Herbst (Universität, Freiburg i. B.). Zentr. Biol. Aerosol Forsch., No. 1-2, 40-60(Aug. 1960). (In German)

The radiation protection situation with respect to contamination of the atmosphere is described. Work with radioactive materials necessitates care greater by an order of magnitude than work with conventional chemical poisons. In industry, natural radioactive materials can lead to contamination of the air of significance from a health physics standpoint. Supplementary potential or actual contamination sources are found in the preparation, application, and elimination of artificial radioisotopes, in connection with the operation of reactors, or in atomic explosions. Results of observations on radioactive particles in the framework of fall-out phenomena are reported. The biological problems resulting from inhaling radioactive materials and the possibility for the modification of the photography industry by uncontrolled distribution of radioactive substances were discussed. Methods for the determination of the radioactive materials contaminating the air were compiled with consideration of the biologically critical atomic species, and the possibilities of suitable protection were outlined. (tr-auth)

1677 RADIOLOGICAL HEALTH DATA, MONTHLY REPORT, VOLUME III, NUMBER 3. (Public Health Service, Washington, D. C.). Mar. 1962. 34p. $0.50(GPO).

Data are tabulated on the radioactivity in samples of air, rain water, surface water, foods, and milk collected during 1960 and 1961. Data are included on levels of Sr^{90} in milk, tap water, and miscellaneous biological samples. Direct measurements were made of the dose of γ radiation from fall-out in Sweden and New York City. Levels of radioactivity in the environment were measured near Cape Thompson, Alaska, in the vicinity of the Knolls Atomic Power Laboratory, the Lawrence Radiation Laboratory, and the S1C Prototype Reactor Facility during the first half of 1961. Data are tabulated showing location, date, size, and type of announced nuclear detonations during Feb. 1962. (C.H.)

1678 UNTERSUCHUNGEN ÜBER DEN STRAHLENSCHUTZ DES PFLEGEPERSONALS BEI GYNAEKOLOGISCHER RADIUMAPPLIKATION AN KLINIKEN OHNE BESONDERE SPEZIALEINRICHTUNGEN. (Radiation Pro-

tection of Personnel During Gynecological Radium Application in Hospitals Having No Special Equipment). Max Paul Ostermeier. Thesis, Erlangen-Nüernberg, Ger., Friedrich-Alexander-Universität, 1961. 28p.

The radiation exposure of nursing personnel in connection with radium therapy was studied. It is concluded that the legal exposure limits can be observed without special equipment. The radiation hazards depend on the selection of the rooms. Each room should be used for one patient only. The dose can be reduced by the application of certain rules to shorten the manipulation time. It is demonstrated that the radiation exposure of a nurse can be kept as low as 13 mr per 24 hr. Dose rate measurements in the radium application room indicate that no disturbance of the normal clinical routine arises. (Gmelin)

1679 ZASHCHITNOE OBORUDOVANIE I PRISPOSOBLENIYA DLYA RABOTY S RADIOACTIVNYMI VESHCHESTVAMI. (Radiation Shielding and Instruments in Handling Radioactive Materials). G. N. Lokhanin, V. I. Sinitsyn, and A. S. Shtan. Moscow, Gosatomizdat, 1961. 130p.

Practical data are given on protective measures and rules in handling radioactive materials in a laboratory. The laboratory equipment and furniture, shielding chambers, hood exhausts, shielding blocks and screens, and remote-control devices and instruments are discussed. Transportation containers and waste disposal measures are also discussed. Detailed descriptions are given of clothing, boots, and gloves for the personnel handling radioactive materials and waste. (R.V.J.)

1680 MEDICAL FINDINGS AND METHODOLOGY OF STUDIES BY THE ATOMIC BOMB CASUALTY COMMISSION ON ATOMIC BOMB SURVIVORS IN HIROSHIMA AND NAGASAKI. J. W. Hollingsworth, G. W. Beebe, M. Ishida, and A. B. Brill (Atomic Bomb Casualty Commission, Hiroshima and Nagasaki). p.77-100 of "The Use of Vital and Health Statistics for Genetic and Radiation Studies." New York, United Nations, 1962.

The Atomic Bomb Casualty Commission (ABCC) has been operating since 1947 in Hiroshima and Nagasaki to determine the delayed effects of irradiation on the survivors of the atomic bombings. Certain vital statistical records were of considerable help in developing an epidemiologic survey of such a large group of people. Particularly valuable was the 1950 Japanese National Census that first supplied a relatively complete roster of the exposed population. ABCC studies indicated that in utero irradiated fetuses developed brain damage if the radiation dosage was relatively high and if the fetus was in an early gestational period. Increased numbers of major congenital abnormalities were not detected in the offspring of irradiated parents, but some genetic damage was indicated by the finding of altered male: female at birth sex ratio. Growth and maturation of exposed children appeared somewhat retarded, but it is not clear whether this effect is due to irradiation per se or to socio-economic consequences of the bombings. Small lenticular cataracts developed in those receiving relatively large radiation doses, but morbidity from this condition has been negligible. Leukemia of all clinical varieties except chronic lymphatic leukemia was increased in the irradiated group, with increased incidence first noted 2 to 3 years following the bombing, peaking 5 to 7 years after the bombing, and gradually receding. The increase in leukemia incidence seems crudely proportional to radiation dose. Increased incidence of solid malignant neoplasms of all sites was first detected in 1957 and 1958 in data from the Hiroshima City Tumor Registry, suggesting a long latent period for radiation carcinogenesis in man. No evidence for non-specific aging acceleration has been detected, either by physiologic studies or by longevity determination. However, studies on aging and longevity are continuing. (auth)

1681 IONIZING RADIATION AND HEALTH. World Health Organization Public Health Papers, No. 6. Bo Lindell and R. Lowry Dobson. Geneva, World Health Organization, 1961. 81p. 5s, $1.00, Sw.fr.3.

Data are summarized on the biological effects of ionizing radiations and the interpretation of physical exposure levels. Permissible exposure levels established by the 1957 International Commission on Radiological Protection are given for medical and occupational exposure. Radiation hazards from fallout from nuclear explosions are discussed. (C.H.)

1682 BREATHING MASK FOR PROTECTION AGAINST RADIOACTIVE AEROSOLS. Jacques Labeyrie (to Commissariat à l'Énergie Atomique). Canadian Patent 643,291. June 19, 1962.

A breathing mask with a filter for retaining radioactive aerosols is provided with means for indicating the activity of the aerosols. The means comprises a detector near or in the filter and may have a visual or auditory warning system. (D.L.C.)

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

1683 (BLG-126) ETUDE DU COMPORTEMENT DE QUELQUES VARIETES BELGES DE POMMES DE TERRE SOUMISES A L'IRRADIATION GAMMA. (Study of Behavior of Some Varieties of Belgian Potatoes Subjected to Gamma Irradiation). R. Kirchmann, M. De Proost, P. Demalsy, J. Roderbourg, and L. Nys (Brussels. Centre d'Étude de l'Énergie Nucléaire). July 1962. 30p.

Different varieties of potatoes were irradiated with doses between 5000 and 20000 rads and stored at two different temperatures. Irradiation has a great influence on the weight loss of the potatoes during storage; the degree of sprout inhibition depends on the variety of the potatoes. The glutathione content and the oxygen consumption of potatoes are influenced by irradiation. The greatest effect of irradiation on the chemical composition concerns the starch; an increase in sugar content is observed. The culinary properties of potatoes are not changed by irradiation. (auth)

1684 (MND-P-2640) INSTRUCTION MANUAL—SNAP-7C ELECTRIC GENERATION SYSTEM. [E. Blazek] (Martin Co. Nuclear Div., Baltimore). Oct. 1, 1961. Contract AT(30-3)-217. 60p.

A description of SNAP-7C isotope-fueled electric generation system is presented. The operational limits and transportation, handling, installation, and adjustment procedures are described. Maintenance instructions and emergency and safety precautions are included. (M.C.G.)

1685 (MND-P-2707) STRONTIUM-90 FUELED THERMOELECTRIC GENERATOR POWER SOURCE—FIVE-WATT U. S. NAVY WEATHER STATION. Final Report. (Martin-Marietta Corp. Aerospace Div., Baltimore). [nd]. Contract AT(30-3)-217. 127p.

The SNAP-7C 10-watt Sr^{90} thermoelectric generator, the converter, batteries, and weather station housing that were delivered to Antarctica in December 1961 are described. Thermoelectric analysis, thermal analysis, fuel form and shielding requirements, generator assembly, electrical system, operational tests, and environmental testing are discussed. (M.C.G.)

1686 (NP-12165) PRESERVATION OF SOFT FRUIT BY IONIZING RADIATION IN THE NETHERLANDS; A FEASIBILITY STUDY. Report No. 2. D. I. Langerak and D. de Zeeuw (Netherlands. Instituut voor Toepassing van Atoomenergie in de Landbouw, Wageningen). [196?]. 72p.

The possibilities of preserving soft fruit by means of ionizing radiation are discussed. A discussion is included concerning economic factors, technology of irradiation, and required research. It is noted that further investigation is required on irradiation before reliable conclusions can be made. (J.R.D.)

1687 (KFK-tr-115) QUANTITATIVE BESTIMMUNG VON ASCHE IN STEINKOHLE IN EINEM SCHNELLVERFAHREN MITTELS β-RÜCKSTREUUNG. (Quantitative Determination of Ash in Coal in a Rapid Process by β Backscattering). H. Mori and S. Taira. Translated into German by Peter Buriks (Kernreaktor Bau- und Betriebs-Gesellschaft m.b.H., Karlsruhe, Germany) from Bunseki Kagaku, 10: 1331-5(1961). 11p.

A sample crushed and dried to 100 mesh was irradiated with β particles from a Sr^{90} source. The back-scattered radiation under an angle of 135° was detected using a Geiger-Mueller tube with a measuring time of 3 min. Twenty-eight kinds of coal with ash contents between 6 and 30% were investigated in this way. The standard deviation amounted to 0.85% of the ash content. The chief reason for this error is the varying composition of the individual components of the ash. A further increase in the measurement sensitivity may be achieved only by plotting standard curves for the individual coal samples. (tr-auth)

1688 THE EFFECTS OF Co^{60} γ-RAYS ON FRIED BEAN CURD. IV. VOLATILE ACIDS AND H_2S. V. ISOLATION OF CARBONYL COMPOUNDS BY PAPER CHROMATOGRAPHY. Chieko Urakami, Satomi Hara, and Hitomi Takahashi. Eiyo To Shokuryo, 13: 141-8(Sept. 1960).

Samples of fried bean curd were irradiated by a pool-type irradiator under an ice cooling system at 1, 1.5, and 3×10^6 r. Studies were made on the outer crust and the protein portion in order to determine the steam volatile acids and the sulfhydryl group. No significant differences were noted between the irradiated and unirradiated samples, and only one acid (CH_3COOH) was found to be present. Paper chromatographic tests showed the same carbonyl numbers for irradiated and unirradiated samples. (OID)

1689 THE EFFECTS OF Co^{60} γ-RAYS ON FRIED BEAN CURD. VI. THE EXAMINATION OF HEATED SOYBEAN OIL AND THE OIL ABSORBED IN THE OUTER CRUST OF THE BEAN CURD IN RELATION TO THE IRRADIATION ODOR. Chieko Urakami, Michiko Hosomi, and Keiko Tomonaga. Eiyo To Shokuryo, 14: 281-4(Nov. 1961).

The results of chemical, paper chromatographic, the UV spectrophotometric analyses on the irradiated (total dosage of 3×10^6 r) oil extract of fried bean curd crust and heated soybean oil (80–90°C) are given. The irradiation odor was much stronger from the crust oil than from the heated soybean oil. Their chemical compositions were also vastly different. (OID)

1690 THE EFFECTS OF Co^{60} γ-RAYS ON FRIED BEAN CURD. VII. THE EXAMINATION OF OIL EXTRACTED FROM THE PROTEIN IN RELATION TO THE IRRADIATION ODOR. Chieko Urakami, Michiko Hosomi, and Keiko Tomonaga. Eiyo To Shokuryo, 14: 285-8(Nov. 1961).

Analyses on the oil extracted from the irradiated fried bean curd showed that the paper chromatographic technique employed was not an efficient means for detecting irradiation effects. It was noted also that UV absorption spectra from the samples were not in accord with the results from the chemical analyses. However, best results were obtained at a λ max of 230 mμ, and 253–258 mμ with respect to the relationship between the irradiation effects and odor. (OID)

1691 THE EFFECTS OF Co^{60} γ-RAYS ON FRIED BEAN CURD. VIII. THE EXAMINATION OF STEAM-VOLATILE CARBONYL COMPOUNDS IN RELATION TO THE IRRADIATION ODOR. Chieko Urakami, Michiko Hosomi, and Keiko Tomonaga. Eiyo To Shokuryo, 14: 289-93(Nov. 1961).

Results from 2,4-dinitrophenylhydrazones of steam-volatile carbonyls liberated from heated soybean oil and oils extracted from the fried soybean curd crust and fractionated into mono- and poly-carbonyl groups are tabulated.

Only mono-carbonyls were observed, and they were fractionated chromatographically by a Hyflo-supercell-nitromethane column. The nature of each compound was studied by means of its UV absorption band. The resulting protein and water content of the samples contributed to the odor. (OID)

1692 DEFORMATION OF THE ASH CONTENT OF COALS BY USING RADIOACTIVE ISOTOPES. Mihaly Nagy and Karoly Varga. Energia Atomtech., 15: 417-25(Sept. 1962). (In Hungarian)

Previous studies on the determination of the ash content and of the calorific value of coal specimens from the Pécs region were continued for the purpose of clarifying the effect of the moisture content, particle size, and degree of compaction on the precision of the measurements; parallel tests were made by classical methods. A Po-Be source was used for the determination of the moisture content, taking advantage of the slowing down of the emitted fast neutrons by elastic collision and back scattering. Results obtained with the device which contained a BF_3-filled proportional counter were not conclusive; further work is in progress. Investigations carried out with a 5-millicurie Tm^{170} source, together with a decimal scaler and a scintillation counter were more successful: the ash content could be determined with a precision of ±1.27% and the ash content within 100 to 150 kcal/kg, thus approaching but not quite reaching the permissible error of the Government Specifications. These results may be further improved by taking the standard uniform density into account and by improving the sampling technique through the use of a mechanical compaction method. (TTT)

1693 EXPERIENCES AND THE QUALITY TESTING OF COAL BY THE β BACKSCATTERING METHOD. E. Dahn and G. Brunner (Institut fllr Angewandte Radioaktivitat, Leipzig). Isotopen Tech., 2: 201-4(July 1962). (In German)

After a short description of the physical principles for quality testing coal and coke by β backscattering, some sample measurements are reported and the results are discussed. (tr-auth)

1694 CONTINUOUS CONTROL AND REGULATION OF THE MOISTURE CONTENT OF BULK MATERIAL BY THE NEUTRON SCATTERING METHOD. Herbert Neuhaus, Friedrich Hombech, and Wilhelm Kuehn (Klockner-Werke A. G., Hutte Haspe, Ger.). Stahl Eisen, 82: 1017-26 (July 19, 1962).

Two ways of determining moisture in sinter-roasting of fine ores are discussed: the activation of metal foils of Rh and Ag, and the scattering of neutrons by the hydrogen nuclei of water. The latter method, which offers the possibility of continuous control of the moisture content of sinter mixtures, was studied on a laboratory scale on individual ores and composite fine ore mixtures of different grain size, bulk density, and chemical composition. A 10-mC Ra–Be capsule, which was properly shielded against the Ra gamma radiation, was used as the neutron source. The pulse rate was primarily dependent on the chemical composition, the hydrate water, and secondarily on the bulk density and geometry of the measurement arrangement. The measuring accuracy was better than 0.5%. The described humidity measurement method was applied to cinder, coke, and breeze (small grain coke) in which grain size influences the measuring results more than in any other bulk material. (OID)

1695 EINFÜHRUNG IN DIE MESSTECHNIK DER KERNSTRAHLUNG UND DIE ANWENDUNG DER RADIOISOTOPE. (Introduction to Measurement Techniques in Nuclear Radiation and the Application of Radioisotopes). Heinrich Fassbender. Stuttgart, Georg Thieme Verlag, 1962. 435p. DM 49.50.

Measurement techniques for radiation are discussed. Methods of detecting ionizing radiation include: optical method by scintillation, autoradiography, cloud chambers, ionization chambers, counting tubes, scintillation counters, and crystal counters. Impulse-estimating and continuous-estimating radiation measurement apparatus and auxiliary equipment are described. The practical accomplishments of radiation measurements are outlined. The use of radiation-measuring apparatus and radioisotopes in medical research and biochemistry for diagnosis and therapy, use of measuring apparatus in x-ray spectral analysis, use of radionuclides in chemistry, use of radioisotopes in engineering, and other uses of radioisotopes and radiation-measuring apparatus are described. Radiation protection is discussed. Arrangements and helps for isotope laboratories and nuclear instrumentation for reactors are described. (M.C.G.)

1696 METHOD FOR TRACING SEPARATION PROCESSES. (to California Research Corp.). British Patent 909,032. Oct. 24, 1962.

A method is given for determining the proportion of a component of a mixture in at least one of several streams resulting from the passing of a principal stream through a process zone. The method comprises introducing a radioactive material isotopic with the component into the zone, measuring the flow rate of at least one of the several product streams, and determining the proportion of the component in the stream by integrating the detector response to the stream and comparing the result with the total amount of radioactive material added to the principal stream. When a soft beta emitter, e.g., C^{14} or T, is used, a scintillation liquid is also added to the stream for producing light pulses. Examples of practical applications of this method are given. (D.L.C.)

1697 PRESERVATION OF MEAT. Robert Crittenden Ottke and Charles Franklin Niven, Jr. (to Chas. Pfizer and Co., Inc.). U. S. Patent 3,057,735. Oct. 9, 1962.

A method is given for extending the storage or shelf life of meats. The method comprises subjecting the meat to intimate contact with a tetracycline antibiotic and then to relatively low ionizing radiation. The amount of antibiotic and irradiation should be 1 to 25 ppm and 65,000 to 500,000 rep, respectively, and 500 to 2000 ppm sorbic acid is preferably also added. (D.L.C.)

INSTRUMENTS AND INSTRUMENTATION

General and Miscellaneous

1698 (DESY-A2,92) DER LAWINENTRANSISTOR UND SEINE ANWENDUNG IN DER HOCHENERGIE-ELEKTRONIK. (The Avalanche Transistor and Its Application in High-Energy Electronics). Hans-J. Stuckenberg (Deutsches Elektronen-Synchrotron, Hamburg). July 1962. 26p.

The avalanche transistor utilizes the very fast current increases by breaking down of the collector voltages. The mechanisms of the transistor are described. On account of the speed of the current multiplication the transistor is considered especially suited for the nanosecond region. Selection of avalanche transistors is discussed. Wiring techniques are described. A special advantage is the simplicity of the wiring which the avalanche transistors have in common with tunnel diodes. (M.C.G.)

1699 (DESY-A2,93) DIE TUNNELDIODE UND IHRE ANWENDUNG ALS SCHNELLES SCHALTELEMENT. (The Tunnel Diode and Its Application to Rapid Line Elements). Hans-J. Stuckenberg (Deutsches Elektronen-Synchrotron, Hamburg). July 1962. 42p.

The mode of action of the tunnel mechanism is described. Measurements of the characteristic data are discussed. Grid parts for tunnel diodes, switching with tunnel diodes, uses as trigger, and flip-flop wiring with tunnel diodes are described. The tunnel diode is considered to be especially suited for very fast switching in the pico- and nanosecond region. (M.C.G.)

1700 (HW-71051) AN AUTOMATIC GAMMA SAMPLE CHANGER. U. L. Upson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 1961. Contract AT(45-1)-1350. 23p.

The sample changer described accommodates dry or liquid samples in jars or dishes and is used in conjunction with a sodium iodide scintillation detector and a multi-channel pulse-height analyzer with automatic data print-out. Maximum sample size is $2\frac{15}{16}$-in. diam. by $3\frac{7}{8}$-in. high, to accommodate a standard screw-top eight-ounce jar. Smaller jars or dishes are transported and centered by means of carriers. The changer's major components are a continuously moving storage table and an intermittently moving turret. Sample sequence is continuous and is maintained. For any number of samples from 2 to 61, the first sample is automatically recounted following the last sample. This fixed sequence permits repetitive counting at fixed intervals as for half life studies. Sample change is obtained on command from the analyzer ("Print" cycle) or from the operator. The detector also is accessible for manual use. For a three-inch diameter by three-inch crystal, the background (up to 2 Mev) is about 300 c/m, and seldom exceeds 10 to 12 c/m for any 0.01 Mev interval. A monitor circuit supplies information to the data printer to indicate any malfunction of the changer mechanism. The instrument operates unattended overnight and over week ends, and has operated without fault for over a year. (auth)

1701 (JÜL-53-PP) ENTWURF UND BAU EINER DREHSPIEGELKAMERA ZUR ZEITLICHEN AUFLÖSUNG VON SPEKTREN IM WELLENLÄNGENBEREICH VON 2000–7000 Å. (Design and Construction of a Rotating-Mirror Camera for Time Resolution of Spectra in the Wave Length Region of 2000 to 7000 Å). Heinz Hartwig (Kernforschungsanlage. Institut für Plasmaphysik, Jülich, Germany). May 1962. 42p.

A rotating mirror camera was developed and constructed according to the principle of the smear camera. It is more suitable for the time resolution of spectrograms than short-time closures for spectrographs and smear cameras. The construction was planned so that all special requirements which result from the spectroscopy in the visible and near ultraviolet spectral regions in experiments with fast magnetic compression of a high-temperature plasma will be satisfied. A transmittancy range of 2000 to 7000 Å, a resolution time of 10^{-7} sec, a relative aperture of f:6.3, and an accuracy of synchronization of 10^{-8} sec were attained. For testing the camera, time-resolved spectra of a short period light source were taken. The spectral transmittancy and the shutter factor of the camera were measured. (tr-auth)

1702 (LADC-5524) READOUTS FOR MULTIPARAMETER ANALYZERS. C. F. Beckett, J. D. Gallagher, and R. B. Glascock (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract W-7405-eng-36. 32p.

The existing multiparameter analyzers of the delayed time totalizing or non-sorting type are described with emphasis on the data recording portion of the analyzer. The existing readout systems for multichannel pulse height analyzer are comparable to the readout required for the real time totalizing multiparameter analyzer. The format and other requirements for a recording compatible with IBM computers are discussed to show what may be required for future recording systems. (M.C.G.)

1703 (NAA-SR-7394) DEVELOPMENT OF A CALORIMETER FOR RADIATION ENERGY MEASUREMENT. S. Berg, N. M. Ewbank, and J. F. Zack, Jr. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 15, 1962. Contract AT-11-1-GEN-8. 32p.

A calorimeter and associated instrumentation system designed to measure radiation energy absorbed by irradiated samples of terphenyls and other materials are described. The complete calorimeter system was designed to continuously and instantaneously measure the rate at which radiative energy was absorbed in a sample, record and display this information, and automatically present the total integrated energy dose in a visual display. Under identical environments, the radiation energy deposition rate of a sample was measured by monitoring the electrical power required to maintain temperature equality between an empty cell and a sample cell. The primary laboratory development work for this calorimeter system was completed and several prototype calorimeters were operationally tested. Inpile operation of prototype calorimeters demonstrated the workability of the synchronic calorimeter concept. (auth)

1704 (NLCO-856) DESIGN AND CONSTRUCTION OF A URANIUM SATURATION MONITOR. J. G. Nuckels, A. E. Abbott, and J. A. Williamson (National Lead Co. of Ohio, Cincinnati). Oct. 22, 1962. Contract AT(30-1)-1156. 28p.

An automatic instrument system was designed, constructed, and successfully operated to prepare U-saturated samples of organic solvent, and to determine the U concentration of these saturated samples. With this

information, a practical basis exists for the efficient operation of the U extraction columns. (auth)

1705 (ORNL-3348) PULSE AMPLIFIER MANUAL. E. Fairstein (Oak Ridge National Lab., Tenn.). Oct. 26, 1962. Contract W-7405-eng-26. 116p.

A manual was prepared to aid those who use and repair pulse amplifiers. The manual is divided into three sections: section 1 contains a number of generalized testing routines applicable to all pulse amplifiers; section 2 is devoted to test information relating to specific amplifiers; and section 3 is a bibliography of journal articles, reports, and books about pulse amplifiers. (auth)

1706 (SC-4733(M)) OPERATING MANUAL FOR THE SANDIA CLEAN BENCH. R. C. Marsh and W. J. Whitfield (Sandia Corp., Albuquerque, N. Mex.). Nov. 1962. Contract [AT(29-1)-789]. 11p.

Initial checkout, operation, and maintenance procedures are set forth for a clean bench, or clean work station, designed to provide an uncontaminated atmosphere in an uncontrolled area. (R.J.S.)

1707 (TID-14021) POWER TRANSFORMER FOR USE IN HIGHLY RADIOACTIVE ENVIRONMENTS. R. D. Carlson and R. J. Schiltz (Argonne National Lab., Ill.). Aug. 1961. Contract [W-31-109-eng-38]. 11p. (UAC-5551)

A power transformer was developed which can operate in a radioactive environment at temperatures up to 425°C for an extended period of time without deterioration. The materials of fabrication were anodized aluminum, mica, lavite, and iron which are all quite radiation resistant. Although no irradiation test was performed, the transformer operated successfully for 5000 hours at 425°C. (auth)

1708 (TID-16570(Del.)) LINEAR DISPLACEMENT SENSING EQUIPMENT. F. A. Ludewig (General Electric Co. General Engineering Lab., Schenectady, N. Y.). Aug. 18, 1960. Contract [W-31-109-eng-52]. 37p. (60GL188(Del.))

The development of a noncontacting type of displacement measuring sensor is described. The sensor consists of a magnet imbedded in a moving member and a magnetic pickup located 2 in. away. Relative motions as small as 0.001 in. between the magnet and the pickup can readily be measured. The sensor can operate at temperatures up to 600°F. This sensor measures the position of a member which is at rest or in motion at vibrating frequencies up to 600 cps. (auth)

1709 (TID-16973) INVESTIGATION OF AN AIR EJECTOR PUMP FOR HIGH ALTITUDE SAMPLING SYSTEMS. A. R. McFarland (General Mills, Inc., Minneapolis). May 15, 1962. Contract AT(11-1)-401. 60p.

Results of analytical and experimental studies involving an air ejector pump having design parameters compatible with collection devices used in high-altitude sampling systems are presented. It is felt that the investigation establishes the feasibility of the use of such pumps. (J.R.D.)

1710 (TID-17194) FLAMMABLE GAS EXPLOSION IN LARGE OIL CIRCUIT BREAKER. J. R. Johnston (Oak Ridge Gaseous Diffusion Plant, Tenn.). [1962]. Contract [W-7405-eng-26]. 18p.

On August 15, 1962, an explosion of flammable gases was experienced in a 161 KV oil circuit breaker tank at the Oak Ridge Gaseous Diffusion Plant. This breaker was drained of oil and opened for inspection to determine the cause of high contact resistance detected during routine testing of the breaker. Circumstances preceding the accident, the accident, and investigations following the accident are described. Recommendations for preventing further accidents of this type are presented. (M.C.G.)

1711 (WCAP-1900(Add.)) THERMOELECTRIC NUCLEAR FUEL ELEMENT. Addendum to Final Report. Joseph C. Danko (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Mar. 30, 1962. Contract AT (30-3)-500. 10p.

A twenty-couple fission-heated thermoelectric generator, TE-5, was tested in the Westinghouse Testing Reactor. The open circuit voltage, instantaneous closed circuit voltage, steady state closed circuit voltage, instantaneous closed circuit current, and steady state closed circuit current were monitored during the 23-day cycle. The initial power output was 110 watts (48 amps at 2.3 volts) at a T_H of 660 to 690°C and a T_C of 130°C. After 23 days the output was approximately one watt. (auth)

1712 METHOD FOR THE MEASUREMENT OF THE LIFETIME OF THE EXCITED STATE OF AN ATOM. Ozve Aminian (Institut Astrophysique, Paris). Compt. Rend., 255: 486-8(July 16, 1962). (In French)

An electronic method for improving the delayed coincidence method in the measurement of the lifetime of the excited state of an atom is proposed. A gate circuit which used tunnel diodes was studied. For the tunnel diode 1 N 3219 the calculation led to a rise time of the order of 0.8 nsec. (tr-auth)

1713 NAVY PREPARES FOR VLF DETECTION OF NUCLEAR BLASTS. Roy J. Bruun. Electronics, 35: No. 42, 28-30(Oct. 19, 1962).

A very-low-frequency (vlf) ionospheric sounder was built for gathering short-path data on transient vlf phase changes in the ionospheric D layer. The transmitter antenna, designed to minimize groundwave to the receivers, consists of two horizontal dipoles crossing each other at their centers, each dipole being 5.5 miles long. Three receivers are spaced at distances of 50 to 150 km. The operation of the sounder is described briefly. (D.L.C.)

1714 THE PRESENT STATUS OF SILICON SOLAR CELLS. Peter A. Iles (Hoffman Electronics Corp., El Monte, Calif.). IRE (Inst. Radio Engrs.), Trans. Military Electron., MIL-6: 5-14(Jan. 1962).

The present state of the art of silicon solar cells is described. The physical properties, circuit performance, and current lines of research are summarized. Silicon is seen to be competitive in several of the newer approaches to solar cell improvement. (auth)

1715 ESTIMATE OF SPACE-RADIATION EFFECTS ON SATELLITE SOLAR-CELL POWER SUPPLIES. J. M. Denney, R. G. Downing, S. R. Lackman, and J. W. Oliver (Space Technology Labs., Inc., Los Angeles). IRE (Inst. Radio Engrs.), Trans. Military Electron., MIL-6: 14-20 (Jan. 1962).

The charged-particle intensity and energy distribution at the heart of the inner and outer Van Allen belts is compared with the experimentally determined radiation sensitivity of silicon solar cells. Energy dependence of the radiation damage and solar-cell characteristics is included in the lifetime estimate of spacecraft solar cells. Use of charged-particle range-energy relations and the differential intensity of the Van Allen radiation results in an estimated effectiveness of thin protective shields. Comparative advantages of thin shields, advanced cell designs, solar efficiency, and solar-cell system over-design are discussed with respect to radiation resistance of spacecraft power supplies. (auth)

1716 CHARACTERISTICS OF HIGH-CONVERSION-EFFICIENCY GALLIUM-ARSENIDE SOLAR CELLS. A. R.

Gobat, M. F. Lamorte, and G. W. McIver (Radio Corp. of America, Somerville, N. J.). IRE (Inst. Radio Engrs.), Trans. Military Electron., MIL-6: 20-7(Jan. 1962).

Gallium-arsenide solar cells having conversion-efficiency values greater than 11 per cent are described. Crystalline properties of gallium arsenide are discussed, and cell design considerations are given. Gallium arsenide provides several advantages over silicon in the fabrication of high-efficiency cells having improved temperature characteristics and higher radiation-resistance properties. Typical cell characteristics are presented and compared with those of silicon cells. In addition, data are given to show the effects on gallium arsenide cells of incident solar energy, temperature, radiation, and life. (auth)

1717 PROGRESS IN THERMOELECTRICITY. Paul H. Egli (Naval Research Lab., Washington, D. C.). IRE (Inst. Radio Engrs.), Trans. Military Electron., MIL-6: 27-34 (Jan. 1962).

Of the several processes by which heat is directly transformed to useful electric power, thermoelectricity offers unique advantages for several areas of application. The absence of moving parts and the simplicity promise high reliability, silence, and long-lived, maintenance-free operation both as a power source and as a heat pump for refrigeration and temperature control. A substantial effort devoted to materials development has produced new semiconductors with an integrated theoretical efficiency of about 20 per cent. Further progress in materials development is needed to achieve major goals in both military and commercial applications, but important uses can already be visualized. Small power plants for remote areas and auxiliary power supplies for space vehicles are awaiting engineering improvements, some of which again require improved materials for use as electrical contacts and electrical and thermal insulators. Similarly in refrigeration, important military applications and special commercial devices can be produced with existing thermoelectric materials when engineering problems and the auxiliary materials problems are solved. (auth)

1718 THERMOELECTRIC GENERATOR DESIGN, PERFORMANCE, AND APPLICATION. T. M. Corry and G. Spira (Westinghouse Electric Corp., Pittsburgh). IRE (Inst. Radio Engrs.), Trans. Military Electron., MIL-6: 34-40(Jan. 1962).

Many of the practical problems that are encountered in building present-day generators are illustrated. A design procedure for free convection air-cooled generators is described. The performance of power thermocouples as a function of junction temperature is discussed and curves illustrating couple efficiency, power output, heat flux and voltage as a function of hot junction temperature are shown. The effects of varying thermocouple length on generator efficiency and generator specific power are shown graphically and methods of predicting generator performance are illustrated for thermoelectric materials of equal figures of merit but different values of thermal conductivity. Free convection heat exchangers and fossil-fuel burners are also discussed. The thermoelectric generator performance on a watts-per-pound basis is compared with battery- and gasoline-engine-driven generator performance for specific missions. (auth)

1719 THERMIONIC CONVERSION — STATE OF THE ART. Theodore Jarvis (Ford Instrument Co., Long Island City, N. Y.). IRE (Inst. Radio Engrs.), Trans. Military Electron., MIL-6: 41-5(Jan. 1962).

After a brief discussion of fundamental principles, a family tree of the different types of thermionic converters is presented. The status of individual conversion techniques is then reviewed. A description of the materials problems is given. The review concludes with projections of development and performance trends of the most important types of thermionic converters. (auth)

1720 RADIOISOTOPE-ACTIVATED FUEL-CELL ELECTRODES. Maurice Lang (Yardney Electric Corp., New York). IRE (Inst. Radio Engrs.), Trans. Military Electron., MIL-6: 58-62(Jan. 1962).

It has been shown that a catalytic effect can be produced on oxygen fuel-cell electrodes by the incorporation of radioactive isotopes into the electrode structure. Experiments with β emitters resulted in low-temperature and -pressure silver electrodes capable of high current drains at favorable polarization values. Analysis of the data indicates support for the hypothesis that radiations exert a significant effect on diffusion control within the pores of the electrode. (auth)

1721 THE MAGNETOHYDRODYNAMIC POWER GENERATOR — BASIC PRINCIPLES, STATE OF THE ART, AND AREAS OF APPLICATION. A. R. Kantrowitz, T. R. Brogan, R. J. Rosa, and J. F. Louis (Avco-Everett Research Lab., Everett, Mass.). IRE (Inst. Radio Engrs.), Trans. Military Electron., MIL-6: 78-83(Jan. 1962).

A review and discussion of the basic principles of MHD power generation are presented. It is seen that the MHD generator operates in a manner similar to that of a conventional generator in that the "armature" of the MHD is a hot, high-speed electrically conducting gas, while the force or torque required to move a metallic conductor through a field is replaced by a pressure gradient in the gaseous armature. Thus the functions of turbine and generator are combined in a single machine. Because this machine has no moving parts, it can, in principle, accept a working fluid at very high temperature. After a derivation of the basic MHD-generator flow equations, a brief synopsis of losses in an MHD generator is given. The nature of these losses is such that the MHD generator is applicable where large amounts of power are involved. In gases, the Hall effect can be very pronounced, and its influence on MHD generator design and performance is pointed out. A brief statement is given of the state of the art in MHD-generator development at the Avco-Everett Research Laboratory. It is shown that gases produced by conventional heat sources can be made adequate conductors of electricity for use in an MHD if a small amount of easily ionizable impurity called seed is added to the gas. Recent developments in superconducting materials, plus detailed studies of MHD-generator fluid mechanics in a large combustion-driven generator point to early realization of the potential of MHD. Finally, some potential applications of MHD are suggested. These applications lie in the areas of central station power generation, shipboard propulsion, limited duration, high-power units, and energy storage and discharge in some ranges now covered by capacitor and inductive devices. (auth)

1722 SOLAR-CELL POWER SYSTEMS FOR SPACE VEHICLES. Nathan W. Snyder (Royal Research Corp., Hayward, Calif.). IRE (Inst. Radio Engrs.), Trans. Military Electron., MIL-6: 84-91(Jan. 1962).

For operational purposes, solar-cell power systems are being used in the 30 or 40 different spacecraft now planned for flight. The range of power is from 15 to 500 watts. Both nonorientation and orientation of paddles to the sun are being used. An approximate break-even point between excessive weight of solar cells for nonoriented systems and weight of the orientation servomechanism system for solar-oriented systems occurs for a power level of 100 watts. Nickel-cadmium batteries have been used for the storage of

electrical energy, whether for providing power during shadow periods encountered by low-altitude spacecraft or providing peak power during telemetry for interplanetary flights. The specific weight of such power systems varies from 750 or 1000 lb/kw to 500 lb/kw for orbits from 300 miles (statute) to 22,000 miles (synchronous orbit). Reduction in weight of batteries as well as solar cells needed for battery charging as altitude increases is responsible for this decrease in specific weight because of the decreasing time of shadow encountered by an orbiting spacecraft. (auth)

1723 SOLAR DIRECT-CONVERSION POWER SYSTEMS. William C. Cooley (Exotech, Inc., Alexandria, Va.). IRE (Inst. Radio Engrs.), Trans. Military Electron., MIL-6: 91-8(Jan. 1962).

A survey is made of the present status of technology of solar photovoltaic, photoemissive, thermoelectric, and thermionic power systems for spacecraft. The subjects of radiation damage to solar cells, power-system design, and solar simulation are reviewed. Various types of solar power systems are discussed and compared with respect to weight, availability, environmental tolerance, and cost. It is concluded that solar photovoltaic and solar thermionic systems are most desirable for power levels up to 3 kw. However, the life capability of thermionic converters has not yet been established. Solar thermoelectric and photoemissive systems will be less desirable because of their lower efficiency and, therefore, larger area per unit power output, except for missions where radiation resistance or economy are paramount considerations. (auth)

1724 THE CESIUM-137 THERMOELECTRIC GENERATOR. H. O. Banks, Jr. and W. W. T. Crane (Royal Research Corp., Hayward, Calif.). IRE (Inst. Radio Engrs.), Trans. Military Electron., MIL-6: 98-102(Jan. 1962).

Designed for the initial application of supplying power for an under-sea seismic station to be supervised by Lamont Geological Observatory researchers, this cesium generator incorporates an external shell that will withstand compressive forces at the greatest of ocean depths and a power-conversion system employing lead-telluride thermocouples mounted on a printed circuit board. A combination radiation shield and heat sink, surrounded by a special complex of thermal reflectors and compacted insulation, utilizes practically all of the decay heat. A very high degree of safety from radioactivity is assured, due to double encapsulation of fuel increments, an ultrastrong radiation shield for containment of the latter, and an external shell that will withstand 16,000 psi pressure. (auth)

1725 SERVOMECHANICAL FUNCTION GENERATOR FOR A KINETIC REACTOR ANALOG. Radoslav Kalivoda (Lenin Works, Pizen, Czechoslovakia). Jaderna Energie, 8: 168-71(1962). (In Czech.)

The servomechanical function generator consists of a cylindrical roller surface which is made of an electrically conducting material, a sheet of nonconducting paper, and a set of contacts moved by a servomotor. The cylindrical roller rotates at a constant speed. The sheet of paper that rolls over the cylinder is cut in the form of the function being generated; one contact of the set presses against the cylindrical roller and is made to follow the cut edge of the paper by means of a servomotor. The direction of motion of the servomotor depends on whether this contact is lying on the insulating paper or the bare conducting drum. The other contact of the movable set rides along a rod-type potentiometer and it furnishes an output voltage that is linearly dependent on the position of the first contact. This position of the first contact can simulate the instantaneous neutron flux of a reactor while the distance between this position and the edge of the paper (i.e., the difference between) is a measure of the excess reactivity. The dynamic characteristics of the kinetic reactor analog can be varied by varying the servomotor output torque, the friction loading, C, of the servomotor and other parameters. These dynamic characteristics are presented in terms of the frequency and amplitude of the characteristic oscillations of the system. (TTT)

1726 SIGNAL-TO-NOISE RATIO OF THE TWIN-T NUCLEAR MAGNETIC RESONANCE BRIDGE. D. Gheorghiu and A. Valeriu (Inst. for Atomic Physics, Bucharest). Nucl. Instr. Methods, 16: 313-16(Aug. 1962). (In English)

Analysis of a twin-T bridge used in nuclear magnetic resonance showed the conditions that must be fulfilled to obtain a maximum of the signal-to-noise ratio. The maximum value is practically equal to that of the crossed-coil system. (auth)

1727 A RING-CORE MAGNETIC STORER FOR 128 CHANNELS. Walter Helmberger (Technische Hochschule, Munich). Nukleonik, 4: 288-99(Oct. 1962). (In German)

A magnetic parallel storer is described which was built for sorting and storage of data. The storer has 128 storage registers each with 16 bits and a cycle time of 80 μsec. It works according to the flux coincidence method with a selection ratio of 2:1. Its magnetic commutator switch is unconventional and in need of slight directed expenditure. (tr-auth)

1728 HIGHER-PRESSURE MASS SPECTROMETRY. T. W. Martin (Vanderbilt Univ., Nashville), R. E. Rummel, and C. E. Melton. Science, 138: 77-83(Oct. 12, 1962).

The development and design of the higher-pressure mass spectrometer for studies of reactions in radiation and catalytic chemistry are discussed. The mass spectrometer at Vanderbilt Univ. is described in detail. Possible applications and some experimental results obtained are given. (D.L.C.)

1729 FOCUSING PARABOLA SPECTROGRAPH. Siegfried Neumann and Heinz Ewald (Technische Hochschule, Munich). Z. Physik, 169: 224-38(1962). (In German)

A stigmatic focusing parabola spectrograph was constructed consisting of a tandem arrangement of a magnetic and an electric sector field. The mean planes of deflection of these fields are vertical to each other. Each field is giving the focusing in its own direction of deflection. By the use of an electron impact ion source and a circular entrance diaphragm of a diameter of 0.05 mm, a mass resolution of about 2500 and, in the direction of the parabolas, an energy resolution of at least 1000 was obtained. (auth)

1730 THE ENCYCLOPEDIA OF ELECTRONICS. Charles Susskind, ed. New York, Reinhold Publishing Corp., 1962.

Approximately 500 topics on electronics are alphabetically arranged as single entries. Cross references and allied topics are also included. A separate list of contributing authors is given. (P.C.H.)

1731 METHOD OF DETECTING IONS. Norman Richard Daly (to United Kingdom Atomic Energy Authority). British Patent 907,511. Oct. 3, 1962.

An ion detector for mass spectrometers is designed for suppressing unwanted background signals and for distinguishing between ions of the same mass and charge, e.g., H_2^+ and D^+ ions. In the ion detector, the ion beam is passed through an aperture and allowed to strike a thin foil

so that the desired ions liberate secondary electrons from the back of the foil, which are then detected. (D.L.C.)

1732 METHOD AND APPARATUS FOR PRODUCING A PURE STREAM OF CHARGED PARTICLES. (to Bendix Corp.). British Patent 908,490. Oct. 17, 1962.

A time-of-flight mass spectrometer is designed with means for eliminating stray ions. In the mass spectrometer, ionized particles are accelerated at right angles to their initial velocity and collected at a point in the path of the resultant velocity. (D.L.C.)

1733 IMPROVEMENTS IN OR RELATING TO ELECTRIC CONTROL OR MONITORING EQUIPMENT OR APPARATUS. (to E. K. Cole Ltd.). British Patent 908,843. Oct. 24, 1962.

A module is designed for use with control and interlock circuits of reactors which must be fail-safe. The module comprises two transistors interconnected so that when either one is conducting, the other does not conduct, means for stabilizing the circuit when either transistor is conducting, means for feeding signals to one transistor from the control circuit for selecting the stable state, and pulse means for blocking the transistor if it is conducting. A plurality of such modules connected in a cascade may be used as a guard line. (D.L.C.)

1734 MASS SPECTROMETER FOR GASES AT LOW PRESSURES. Jan Peper (to Philips Gloeilampenfabrieken). Canadian Patent 641,689. May 22, 1962.

A mass spectrometer of the omegatron type is designed with the gas sample chamber bound by a special electrode configuration to make the resonant frequency constant throughout the chamber. The boundaries of the electrode configuration comprise the lines of intersection of planes with a surface of revolution of three sheets, which surface is obtained by revolution of a hyperbola about the axis of the electron beam. The electrodes whose boundary lines are determined by the two outer sheets of the surface of revolution are at a small positive voltage relative to the other electrodes. The asymptotes to the hyperbola produced by the axial sections of the surface of revolution are at an angle to the axis of revolution with a tangent equal to $\sqrt{2}$. (D.L.C.)

1735 CONVERGENT NEUTRONIC REACTOR. Lyle B. Borst and Paul A Michael (to Dow Chemical Co.). Canadian Patent 642,347. June 5, 1962.

A convergatron-type neutron amplifier is designed in which a neutron flux is increased stage by stage, where each stage comprises a moderator region, a fuel region, and a thermal neutron absorber region. The amplifier may be modified to reduce the inherent feedback and to enhance the transparency to neutrons in the desired polarized direction. The modifications include inhomogeneous fuel distribution, oriented cavities in the fuel region, and arcuately bent cylinders in the moderator region. (D.L.C.)

1736 ELONGATED ROTATABLE THERAPEUTIC RADIOACTIVE SOURCE. Paul Alexi (to E. Uhlhorn and Co. GmbH). Canadian Patent 643,082. June 19, 1962.

A radiological instrument is designed for ray treatment of various parts of the human body, both externally and within the various body cavities. The instrument comprises a rotatable supporting member on which radioactive elements are mounted for focusing the radiations for a particular therapy treatment. The supporting member may be provided in various shapes and dimensions for different treatments. (D.L.C.)

1737 SELF-CHECKING RADIATION METHOD AND APPARATUS FOR MEASURING MASS PER UNIT AREA OF MATERIALS. Norman Zinkan Alcock and Everett A. Carter (to Canadian Curtiss-Wright, Ltd.). Canadian Patent 647,076. Aug. 21, 1962.

A radiometric gage for measuring the mass per unit area or density of materials is designed whose operation can be checked in the field. The gage comprises a first ionization chamber detector for measuring the radiation passing through the material to give a first d-c signal, a second detector giving a second d-c signal, means for combining the first and second d-c signals in bucking relationship, a movable iris device for controlling the energization of the second detector, means for moving the iris device in response to the combined d-c signal, means for establishing an indicating signal responsive to the position of the iris device, and means for biasing the indicating signal through an ammeter so that zero current passes through the ammeter with a free air gap between the radiation source and the first detector. (D.L.C.)

1738 METHOD AND APPARATUS FOR OPERATING AN ANALYTICAL MASS SPECTROMETER WITH A GETTER-ION PUMP. Ernest W. Boyer (to Continental Oil Co.). U. S. Patent 3,057,996. Oct. 9, 1962.

A method and apparatus for connecting an ion pump to an analytical mass spectrometer are described which eliminate possible contamination due to the species selectiveness of the ion pump. The connection includes means for controlling the conductance of the spectrometer system so that the pump does not pump some species faster than others. (D.L.C.)

1739 DIFFUSION LOGGING. Serge A. Scherbatskoy. U. S. Patent 3,058,000. Oct. 9, 1962.

A gamma-gamma diffusion logging device is designed for detecting materials of high atomic number in well formations. The device comprises a source of soft gamma rays and a detector therefor. In the use of the device, the photons after having reached a certain distance from the detector undergo a diffusion process which reaches spectral equilibrium determined primarily by the photoelectric effect. (D.L.C.)

Radiation Detection

Refer also to abstracts 1178 and 1695.

1740 (AERE-I/R-2641) EFFECT OF DOSIMETER SIZE ON MEASUREMENTS CLOSE TO A RADIOACTIVE SOURCE. D. B. Dove (United Kingdom Atomic Energy Authority. Research Group. Wantage Radiation Lab., Harwell, Berks, England). July 1958. 8p.

Measurements of dose rate close to a source may be in error due to the finite volume of dosimeter used. The magnitude of the correction required is considered for dosimeters of uniform volume sensitivity. (auth)

1741 (AERE-M-595) A DETECTOR FOR THE MEASUREMENT OF PLUTONIUM-239 IN WOUNDS. H. J. Gale, L. H. J. Peaple, and J. E. Richards (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Feb. 1960. 6p.

An instrument using a counter sensitive to the x rays from Pu^{239} was devised for the detection of Pu in wounds in cases where alpha counting is impracticable. A count rate equal to normal background is produced by 0.002 microcuries of Pu at the surface of a wound or by 0.006 microcuries at 4 millimeters below the surface. (auth)

1742 (AFOSR-1729) A BALLOON BORNE APPARATUS FOR MEASUREMENTS OF IONIZING RADIATION IN HIGH ALTITUDES. Technical Note No. 1. H. Erbe

(Max-Planck-Institut für Aeromonie, Institut für Stratosphärenphysik, Lindau/Harz, Germany). Sept. 30, 1961. Contract AF61(052)-372. 10p. (AD-273078)

The need for soft radiation measurements is discussed. A suitable sounding apparatus and the main features of the receiving equipment are described. (auth)

1743 (CEA-2182) ENSEMBLE DE MESURE EN GEOMETRIE 4π POUR ECHANTILLONS RADIOACTIFS DE FAIBLE ACTIVITE β. (Apparatus for 4π Geometry Measurements of Radioactive Samples Having a Low β-Activity). J. Colomer and M. Valentin (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1962. 20p.

A comprehensive measurement system having low background noise, lead-wall protection, and plastic scintillator placed in anticoincidence with a 4π counter is described and its performance discussed. (auth)

1744 (DASA-1275) RESEARCH STUDY OF SURFACE BARRIER DETECTORS. Final Report, December 31, 1960 – February 28, 1962. (Hughes Research Labs. Div. of Hughes Aircraft Co., Malibu, Calif.). Contract DA-49-146-XZ-016. 124p. (AD-273861)

A study was made to determine the feasibility of utilizing p-n junction phosphorous-diffused detectors to map the radiation field of a pulsed reactor and a linear accelerator. The detectors produced large signals in these radiation fields which were easily observed without any amplification. Radiation from the reactor flux had a damaging effect on the detector characteristics. These were examined before and after the irradiations at temperatures ranging from 77 to 325°K. No permanent effects were observed from the gamma field of the linear accelerator at dosages up to 100,000. The fabrication of very thin detectors of dE/dx determinations using charged particles for rapid response to a LINAC beam was examined. The p-n junction detectors used were made by diffusing phosphorous into boron-doped silicon wafers of various resistivities. (auth)

1745 (DP-780) NEW EVALUATION OF LOW GEOMETRY ALPHA COUNTING. Robert F. Overman (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Sept. 1962. Contract AT(07-2)-1. 10p.

Low-geometry alpha counters and alpha-gamma coincidence counters were used to count Am^{241} sources. Comparison of these methods showed results only 0.5% higher by coincidence counting. The agreement between these independent methods of counting confirms the validity of the assumptions used in calculating the results. (auth)

1746 (KAPL-M-FTG-1) OPERATION OF THE SCINTILLATOR PHOTOMULTIPLIER DETECTOR UNDER CONDITIONS OF CHANGING SCINTILLATION RATE. F. T. Gould (Knolls Atomic Power Lab., Schenectady, N. Y.). June 19, 1962. Contract W-31-109-eng-52. 50p.

The characteristics of a photomultiplier scintillator system under conditions of a rapidly changing flux were investigated. The results indicated a sensitivity to rapidly changing high count rates which causes a detector instability in pulsed neutron measurements. The instability was traced to the photocathode surface of the photomultiplier which changes its characteristics as a function of the light output of the scintillator. Since the pulsed neutron sources were not uniform in burst intensity, large effects could be obtained particularly in the case when the source output changed radically. The instability was due to a solid-state effect known as enhancement of photoelectric emission by photon irradiation. (auth)

1747 (NP-12182) DEMOLTIPLICATORE AD ANELLO CON LETTURA MEDIANTE INDICATORI LUMINOSI E COMANDO PER STAMPATRICE. (Scaler for Ring Counter with Luminous Indicator and Trigger for Printer). E. Bartoccini and A. Serra (Italy. Comitato Nazionale per l'Energia Nucleare. Laboratorio di Elettronica, Rome). June 1962. 11p. (RT/EL(62)7)

A ring counter having 0.5 μs resolving time is described. It gives ten different outputs for driving in-line read-out tubes. The trigger circuit for the commercial printer is shown. (auth)

1748 (LADC-5447) EXPERIMENTAL TECHNIQUE FOR HIGH PRECISION CALIBRATION OF WHOLE-BODY COUNTERS: APPLICATION TO A 4π LIQUID SCINTILLATOR AND A LARGE SODIUM IODIDE (Tl) CRYSTAL SPECTROMETER. Phillip N. Dean (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract [W-7405-eng-36]. 28p.

With the 4π liquid scintillator, potassium determinations can be made on random persons to a precision of ±2.1% based on the calibration alone. Including statistics, the precision is ±3.0% for a counting time of 200 seconds. With the crystal spectrometer, potassium determinations can be made on random subjects to a precision of ±2.7% based on the calibration alone. Including statistics, the precision is ±3.5% for a counting time of 50 minutes. (auth)

1749 (TID-16860) INITIAL OPERATION AND PERFORMANCE OF A LARGE MAGNETIC-FIELD SPARK CHAMBER SYSTEM. G. R. Burleson, T. F. Hoang, P. I. P. Kalmus, R. L. Kuskowski, L. Q. Niemela, A. Roberts, T. A. Romanowski, S. D. Warshaw, and G. E. Yurka (Argonne National Lab., Ill.). July 1962. Contract [W-31-019-eng-38]. 9p. (UAC-6659)

A spark chamber is described which has a magnetic field, and is operated with an event-triggered arrangement rather than a strict one such as found in earlier chambers. The performance of the system is discussed including capacity, particle identification, and scanning experience. Data are included on event identification and momentum precision. (J.R.D.)

1750 (UCRL-10280) ELECTRONIC COUNTER TECHNIQUES AT BERKELEY. Clyde Wiegand (California. Univ., Berkeley. Lawrence Radiation Lab.). June 5, 1962. Contract W-7405-eng-48. 15p.

The data acquisition system used in an experiment on pion-pion interactions is reviewed. Other discussion is included on developments in counting techniques. It is noted that only part of the work in progress is reviewed. Comment is included on the use of photomultiplier pulses and stable-output light pulse sources. (J.R.D.)

1751 (USNRDL-TR-580) ENERGY RESPONSE OF LANDSVERK IONIZATION CHAMBERS TO MONOENERGETIC GAMMA RAYS. R. L. Lynn and V. L. DaGragnano (Naval Radiological Defense Lab., San Francisco). May 7, 1962. 26p.

An energy response calibration of Landsverk L-65, L-81, and L-83 pocket chambers was carried out using monoenergetic gamma-emitting radioisotopes. Since the intensity of the sources was low, the pocket chambers were used as ratemeters and the ionization current was read on a vibrating-reed electrometer. The dose rate of each isotope (Co^{60}, Cs^{137}, Hg^{203}, and Ce^{141}) was calibrated with a scintillation spectrometer. The angular response of the chambers for energies of 1.25 Mev, 662 kev, 279 kev, and 145 kev, respectively, was measured in one quadrant. The effect of wall thickness on the energy response was also investigated. (auth)

1752 (KFK-tr-111) IONISATIONS-α-SPEKTROMETER HOHER AUFLOSUNG. (Ionization α-Spectrometer of High Resolution). G. E. Kočarov and G. A. Korolev.

Translated into German by Liselotte Neander (Kernreaktor Bau- und Betriebs-Gesellschaft m.b.H., Karlsruhe, Germany) from Izv. Akad. Nauk SSSR, Ser. Fiz., 25: 237-56 (1961). 37p.

An ionization α spectrometer possessing a high energy-resolution capability and a large light intensity is described. From an accurate determination of the most important factors which influence the resolution, it was possible to ascertain corresponding formulas for the determination of the half-width of the α line and the shift of the maximum. By use of a mixture of argon and methane it was possible to eliminate the addition of electrons to the electronegative impurities. A considerable raising of the drift velocity leads to an improvement of the time and energy resolution capability. By means of electric collimation the resolution capability of the ionization chamber could be improved without noticeable diminishing of the light intensity of the apparatus. (tr-auth)

1753 APPLICATION OF SPARK AND CORONA SPARK COUNTERS IN NUCLEAR RADIATION MEASUREMENT TECHNIQUE. Hans-Joachim Belitz (Universität, Giessen, Ger.). Atomkernenergie, 7: 268-74(July-Aug. 1962). (In German)

The counting behavior of spark and corona spark counters was investigated with reference to their possible use in nuclear measuring technique. According to the investigations, they are only competitive in some cases, as compared to the customary gas discharge counters (ionization chamber and proportional counter). On the other hand, they appear very suitable for use as simple detector instruments for heavily ionizing rays with a strong background of weakly ionizing radiation. A survey is given on the various types of gas discharge counters, and a proposal for nomenclature is made. (auth)

1754 SOLID-STATE DETECTORS WITH PARTICULAR RESPECT TO SURFACE-BARRIER DETECTORS. M. Nasini and G. Redaelli (CISE, Segrate, Italy). Automazione Automatismi, 6: No. 3, 5-19(May–June 1962). (In Italian)

Solid-state detectors represent a very recent subject for study in the field of scientific investigations. Moreover, the development of surface barrier detectors has introduced a new instrument which not only substitutes, but in some cases even supersedes, the classical gas detectors. The history of the development of semiconductor detectors is briefly related. The mechanism of interaction and detection in the detectors and the characteristic parameters of such devices are described. The construction of the Au–Si surface-barrier detectors is briefly indicated. Typical applications are given. 27 references. (auth)

1755 IGNITION OF THE BIPOLAR AUTONOMOUS DISCHARGE IN AN IONIZATION CHAMBER BY α PARTICLES. Nguyen-Trinh Dzoanh (C.N.R.S., Ivry, Seine, France). Compt. Rend., 255: 483-5(July 16, 1962). (In French)

When two electrodes of an ionization chamber are covered with a thin oxide layer, the phenomenon of autonomous discharge can be ignited by the passage of ionizing particles from a radioactive body. The ignition is caused by the "surface" emission of the electrodes. (tr-auth)

1756 FLOW-THROUGH COUNTER IN THE RELEASE RANGE WITH TECHNICAL ARGON. M. Leistner (Institut für Angewandte Radioaktivitat, Leipzig). Isotopen Tech., 2: 210-13(July 1962). (In German)

A Geiger-Mueller flow-through counter with cheap and easily obtainable welding argon as counting gas and isobutanol as quenching supplement is described. The dependencies of the counter characteristics on temperature and flow velocity were investigated. (tr-auth)

1757 UTILIZATION OF Si JUNCTION DETECTORS FOR THE MEASUREMENT OF NEUTRON FLUX IN DD AND DT REACTIONS. J. Depraz, B. Duborgel, G. Grenier, R. Salin (Institut de Physique Nucléaire, Lyon). J. Phys. Radium, 23: 390-2(June 1962). (In French)

Junction detectors can replace advantageously the classical detectors principally because of their simplicity of mounting and the possibility they offer of discriminating between various charged particles. A detection apparatus for measurements on DT and DD reactions is shown graphically. Typical spectra are shown and the errors in the flux measurements are discussed. (J.S.R.)

1758 THE OPERATION CONDITIONS IN CORONA DISCHARGE AREAS FOR SPARK COUNTERS WITH SPHERE OR WIRE ANODES. Daniel Blanc and Paul Laborie (Faculté des Sciences, Toulouse). J. Phys. Radium, 23: Suppl. to No. 6, 57A-69A(June 1962). (In French)

Spark counters of the "wire-plane" type, also called Rosenblum counters, are very good α detectors; being quite insensitive to β and γ rays, they are then useful for neutron detection. A systematic survey of these detectors, studying their working characteristics and especially their pulse types, their sensitive volume, and the counting characteristics of detectors with one or several wires was made. From these measurements, simple design principles are deduced, and it is shown that the characteristics of "wire-plane" counters depend principally on the distance of the wire from the cathode. Finally, it is pointed out that spark detectors will never present a constant efficiency in their whole sensitive volume. (tr-auth)

1759 GASEOUS AMPLIFICATION IN A PROPORTIONAL COUNTER. Alain Lansiart and Jean-Pierre Morucci (Centre d'Études Nucléaires, Saclay, France). J. Phys. Radium, 23: Suppl. to No. 6, 102A-4A(June 1962). (In French)

An explanation is suggested for the deviation from theory of random fluctuations in the multiplication phenomena when one primary electron is considered. It is proposed that the duplication factor α depends on the number of electrons already produced in the multiplication process. A curve is calculated using this assumption and is found to be in excellent agreement with the experiments of Curran, Cockcroft, and Angus. (auth)

1760 A SOFT X-RAY SPECTROMETER WITH PULSED SOURCE, AND SYNCHRONOUS PHOSPHOR-PHOTOMULTIPLIER DETECTOR. A. H. McIlraith (Canterbury University Coll., Australia and Univ. of New Zealand). J. Sci. Instr., 39: 504-8(Oct. 1962).

A soft x-ray spectrometer employing a phosphor, $CaWO_4$: Pb, in its detector is described. A high signal-to-noise ratio is obtained by modulating the output of the x-ray tube with a periodic voltage applied to an auxiliary electrode and using a synchronous detector. The envelope of the molybdenum $M_{IV,V}-N_{II,III}$ emission line at 64 Å was recorded; analysis of this suggests that it contains four components, three of which are attributed to the transitions M_VN_{III}, $M_{IV}N_{II}$, and $M_{IV}N_{III}$. (auth)

1761 CHARACTERISTICS OF AN ALPHA PARTICLE CORONA-STREAMER COUNTER IN AIR. A. J. Tavendale (Univ. of Tasmania, Australia). J. Sci. Instr., 39: 517-18 (Oct. 1962).

Alpha particle wire-plate corona counters in air can be operated in two modes depending on wire diameter and electrode spacing. Conventional Rosenblum spark detector action occurs at low gaps, while at larger spacings

breakdown terminates at the streamer stage of spark development. Advantages of the streamer mode of operation are low counter dead time (0.2 μsec at 300 counts per sec) and absence of electrode corrosion by sparking. (auth)

1762 THE PROPERTIES OF SOME COLLIMATORS FOR USE IN THE SCINTISCANNER. PART I. G. Nentwig (VEB Vakutronik, Dresden). Kernenergie, 5: 542-9(July 1962). (In German)

Collimators can generally be characterized by their sensitivity distributions. Therefore it appears of advantage to introduce measurement conditions in the characteristic magnitudes adapted for medical uses, which would greatly alleviate the manipulation of collimators. A typical collimator apparatus, consisting of three conical collimators of different apertures as well as of a 9-channel, 19-channel and slit-channel collimator, was introduced. The characteristic magnitudes (zero effect, effectivity, resolution, and screening behavior) of the individual types were experimentally determined according to their definition and discussed. (tr-auth)

1763 A γ SCINTILLATION DOSIMETER. G. Blasek and R. Kempe (Technische Universität, Dresden). Kernenergie, 5: 550-3(July 1962). (In German)

A scintillation dosimeter for γ radiation was theoretically treated by Bell and Graham and experimentally tested using construction elements commercially available in the DDR. It was shown that it is possible to obtain, with the SEV M 12 FS, a logarithmic reading from 1 to 10^5 mr/hr. (tr-auth)

1764 A SCINTILLATION SPECTROMETER FOR HIGH ENERGY BETA DECAYS. J. G. Cramer, Jr., B. J. Farmer, and C. M. Class (Rice Univ., Houston, Tex.). Nucl. Instr. Methods, 16: 289-300(Aug. 1962). (In English)

A scintillation spectrometer was developed for application to beta decays having end point energies of 3 Mev or more. The spectrometer uses a large plastic scintillator on which the betas are incident from an external source. The beam of betas is restricted to a narrow cone to insure that virtually the total energy is absorbed within the scintillator. Spectra are recorded with a multi-channel pulse height analyzer. The pulse height scale was calibrated in terms of energy by means of the end points of known beta spectra and the edges of Compton recoil electron distributions from gamma rays. The relationship between pulse height and energy was found to be linear up to 13 Mev. End point energies of spectra can be assigned to an accuracy of 1 to 2% on the basis of the calibration. The response of the spectrometer to monoenergetic electrons for the energies below 3 Mev was found to be essentially Gaussian. Spectra of the beta decays from Ce^{144}–Pr^{144}, Al^{28}, F^{20}, and B^{12} compared favorably with those obtained by magnetic analysis. (auth)

1765 READ-OUT FOR A MANY CHANNEL ANALYZER. H. Ostertag, K. H. Lauterjung, and W. Gruhle (Universität, Cologne). Nucl. Instr. Methods, 16: 301-4 (Aug. 1962). (In German)

An automatic read-out equipment for the Hutchinson-Scarrot pulse-height analyzer is described. The information is read from the screen of the cathode ray tube by means of CdS-photoresistors. An electronic converter gives two output informations: a voltage, analogous to the information in one channel, which is fed into a strip-chart recorder; and an octadic one, driving a printer, which prints the number of pulses stored in one channel. The time required is 4 min 15 sec for 100 channels; 3 min 15 sec for 70 channels, and is independent of the number of pulses stored. (auth)

1766 OPERATING CHARACTERISTICS OF A SUM-COINCIDENCE SPECTROMETER. S. I. H. Naqvi (Univ. of Manitoba, Winnipeg). Nucl. Instr. Methods, 16: 305-9(Aug. 1962). (In English)

A sum-coincidence gamma scintillation spectrometer is described and its operating characteristics evaluated. A linear, stable adding circuit for use in the spectrometer is given. (auth)

1767 1 Mc/s SCALER USING GAS-FILLED COLD CATHODE COUNTING TUBE EZ 10. F. Požar (Nuklearni Institut "Jošef Stefan," Ljubljana, Yugoslavia). Nucl. Instr. Methods, 16: 310-12(Aug. 1962). (In English)

A transistorized driving circuit for a gas-filled cold cathode counting tube EZ 10-B with counting rate up to 1 Mc/s is described. The counting tube is driven by a transistor pulse amplifier containing a pulse transformer. In the following counting stages tubes EZ 10-A or EZ 10-B can be used. (auth)

1768 MEASUREMENT OF THE ENERGY RESPONSE OF A B^{10} SHIELDED U^{235} FISSION CHAMBER. J. K. Basson and J. A. Dennis (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Instr. Methods, 16: 321-5 (Aug. 1962). (In English). (AERE-M-966)

A U^{235} fission chamber enclosed in absorbing shields of B^{10} was used as a threshold detector for intermediate energy neutrons. The energy response was measured by using time-of-flight techniques. The effective fission cross-section of U^{235} when shielded by 1 g cm^{-2} of B^{10} was found to be in good agreement with that calculated by the application of the sphere transmission theory. The agreement for a shield of 2 g cm^{-2} was reasonable. (auth)

1769 A NEW METHOD FOR MOUNTING SCINTILLATION CRYSTALS WITH AN IMPROVED ENERGY RESOLVING POWER. Gy. Máthé (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen) and R. Voszka. Nucl. Instr. Methods, 16: 335-6(Aug. 1962). (In English)

The resolving power of NaI(Tl) crystals employed for gamma spectroscopy was further enhanced by coating their surface with microcrystalline NaI layer. Some of the experiences obtained in connection with the resolving power are discussed. (auth)

1770 A PROBLEM IN THE TREATMENT OF DATA FROM NUCLEAR COUNTERS: THE DETERMINATION OF PARAMETERS FROM GROUPED SAMPLES. S. Schwarz and H. O. Zetterstroem (Research Inst. of National Defense, Stockholm). Nucl. Instr. Methods, 16: 337-47(Aug. 1962). (In English)

In a wide range of primary data from counting processes, such as pulse-height spectra, the continuous distribution to be measured is split into a number of non-overlapping or partially overlapping channels. The relation between the original distribution and the resulting grouped distribution was studied and a necessary and sufficient condition for the Sheppard corrections to be valid was derived. The effect of grouping on a normally distributed sample with infinite statistics was studied in detail. Diagrams are presented permitting corrections to be carried out in practical cases, when only the central part of the peak can be used for determination of parameters. The method can easily be extended to distribution of different structure, such as the skew distributions from semi-conductor counters. (auth)

1771 A PHOTOMETRIC DEVICE FOR TRACK PROFILE MEASUREMENT IN NUCLEAR EMULSION. I. R. Kenyon (Clarendon Lab., Oxford). Nucl. Instr. Methods, 16: 348-53(Aug. 1962). (In English)

A microdensitometer suitable for charge discrimination on short tracks in nuclear emulsion was developed. An

integrated absorption profile was obtained of 6.25 micron segments of track at each reading. Various profile parameters were tested and the normalized area of profile was found to give the best charge resolution between tracks of charges 1, 2, and 3. Separation of ≥3 standard deviations between adjacent charges was obtained down to a residual range of 60 microns. (auth)

1772 A TRANSISTOR PROBE UNIT FOR NUCLEAR COUNTERS. C. Edwards. Nucl. Instr. Methods, 16: 354 (Aug. 1962). (In English)

A transistor probe unit is described, which eliminates the needs for high impedance and short cables at the input. Advantages of the circuit are briefly discussed. (P.C.H.)

1773 STABILIZING THE SUM COINCIDENCE SPECTROMETER. J. L. Demuynck and O. J. Segaert (Natuurkundig Laboratorium, Rijksuniversiteit, Gent, Belgium). Nucl. Instr. Methods, 16: 358-9(Aug. 1962). (In English)

An alternative to the original electronic set-up for the sum coincidence spectrometer is given in order to improve the stability by providing the de Waard feed-back stabilization. A linear adding network is also described. (P.C.H.)

1774 RESEARCH ON THE RESPONSE PROBABILITY OF THE METHANE DIFFUSION COUNTER. Roland Engfer and Haro von Buttlar (Technische Hochschule, Darmstadt, Ger.). Nukleonik, 4: 279-83(Oct. 1962). (In German)

Curve plateaus and impulse height spectra of the counting wire were investigated for a pure beta preparation. From that corrections for the response probability of the counter were obtained. Both the count loss through the discrimination limits of the amplifier and also the apparatus fluctuations of various counters amounted to only about 1%; a correction for secondary impulses in the plateau center is not necessary. As a single parameter the thickness of the counter window has a great influence on the response probability. (tr-auth)

1775 SCINTILLATION SPECTROMETER FOR ELECTRONS WITH REDUCED γ-SENSITIVITY. P. Armbruster and H. J. Specht (Technische Hochschule, Munich). Nukleonik, 4: 283-8(Oct. 1962). (In German)

For determination of the average β energy of fission products in the energy region $0.2 \leqq E_\beta \leqq 8$ Mev in the mass separator of the FRM, a plastic scintillation spectrometer with reduced γ sensitivity was developed. Between the source and scintillator was a transmission counter working in the proportional region. Only the scintillator impulses with coincident counter impulses were analyzed. The arrangement registered, with a detection probability of 6% for all of the β radiation emitted by a source, more than 98% of all by the scintillator. On the other hand the gamma detection probability was reduced by a factor of about 300. By means of lead shielding on all sides the background in the inner half of the hall of the FRM amounted to about 6 coincidences/min. For the appearance of coupled β-γ transitions the portion of the scintillator impulse which consists of β particles in coincidence with γ radiation must be determined with an absorber between the counting tube and scintillator and subtraction from the measurements without an absorber. The coincidence method is, however, here also superior to a simple absorber-difference measurement. (tr-auth)

1776 THE USE OF AN ETHYLENE-FILLED POLYTHENE CHAMBER FOR DOSIMETRY OF MEGAVOLTAGE X-RAYS. David Greene (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Phys. Med. Biol., 7: 213-24(Oct. 1962).

An ionization chamber, made from polythene and filled with ethylene was used as an energy-independent substandard to extend the 2 Mv calibration factor for a Baldwin-Farmer substandard dosemeter. The methods used to intercompare the chambers at the various qualities are described. Using these intercomparisons and measured absorption coefficients, multiplying factors have been derived to convert the readings given by the Baldwin-Farmer dosemeter to rads in water. The factors obtained were 0.941 N, 0.936 N, 0.950 N, for Co^{60}, 4 Mv, and 20 Mv radiations respectively, where N is the N.P.L. calibration factor to convert the dosemeter readings to roentgens at 2 Mv. (auth)

1777 SODIUM IODIDE CRYSTAL DOSIMETERS FOR USE IN SURVEYS OF REGIONS OF HIGH BACKGROUND RADIATION. Francisco X. Roser and Thomas L. Cullen (Universidade Católica, Rio de Janeiro). Science, 138: 145-6(Oct. 12, 1962).

In a study of selected regions of high background radiation in Brazil, thallium-activated NaI crystals were used as density amplifiers for dosimeter film badges. Calibration experiments were made, and the field results are summarized. (auth)

1778 THE SYMMETRY OF THE PULSE-HEIGHT DISTRIBUTION IN A SCINTILLATION SPECTROMETER FOR MONOENERGETIC X RADIATION. W. Hink (Freien Universität, Berlin). Z. Physik, 169: 289-302(Aug. 1962). (In German)

For the $K_{\alpha 1}$ lines of the elements Ti, Fe, Cu, and Mo, the pulse-height distributions at the output of a NaI(Tl) scintillation detector are recorded with an automatically recording single channel pulse-height analyzer. The deviation to be observed in this low energy region of the most probable from the mean value of these distributions is determined and is compared with the computations of Wright. The results may be described by an empirical formula with the energy dependence E^{-2}, while Wright predicts the dependence E^{-1}. (auth)

1779 FILMDOSIMETRIE. GRUNDLAGEN UND METHODEN DER PHOTOGRAPHISCHEN VERFAHREN ZUR STRAHLENDOSISMESSUNG. (Film Dosimetry. Fundamentals and Methods of the Photographic Process of Radiation Dose Measurement). Klaus Becker. Berlin-Gottingen-Heidelberg, Springer-Verlag, 1962. 181p.

The physical and chemical bases of film dosimetry are discussed. Methods of film dosimetry for gamma rays, x rays, neutrons, beta particles, mixed radiation fields, and for special uses are reviewed. Film sensitivity, measurement calculations, film packing and reading, and evaluation of results are discussed. Over 600 references are included. (M.C.G.)

1780 SEMICONDUCTOR NUCLEAR PARTICLE DETECTORS. Bibliographical Series No. 8. (International Atomic Energy Agency, Vienna). 1962. 99p. $1.50(IAEA)

Six hundred and twelve references on semiconductor detectors are presented. The latest references are of May 1962. They are arranged by author under 8 categories: general; preparation and characteristics; heavy-particle detectors; neutron, electron, and photon detectors; dosimetry problems; apparatus and methods; irradiation effects; and miscellaneous. Subject and author indexes are included. (M.C.G.)

1781 A FISSION CHAMBER AND CALORIMETER FOR NEUTRON AND GAMMA DOSIMETRY. R. F. Callaway and W. E. Austin (Lockheed-Georgia Co., Dawsonville, Ga.). Preprint Paper No. CP 62-1074. New York, Ameri-

can Institute of Electrical Engineers, 1962. 7p. $1.00.

The development of nuclear instrumentation is described, for measurement of the radiation field in a cryogenic in-pile test loop to include 1.6×10^7 r hr^{-1} gammas, 10^{11} thermal neutrons cm^{-2} sec^{-1}, and 10^{13} fast neutrons cm^{-2} sec^{-1}. (auth)

1782 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR MEASURING NEUTRON FLUX. Herbert Crossley (to United Kingdom Atomic Energy Authority). British Patent 907,272. Oct. 3, 1962.

A cheap apparatus is designed for measuring integrated neutron flux in a reactor over several months. The apparatus comprises a sealed vessel with several compartments containing articles sensitive to neutron flux over different ranges of neutron energies. The described embodiment contains Co-, Ni-, and Cd-shielded wires and $MgSO_4$. (D.L.C.)

1783 THREE ELEMENT TRIPLE COINCIDENCE COMPTON SPECTROMETER. (to Socony Mobile Oil Co., Inc.). British Patent 908,485. Oct. 17, 1962.

A scintillation coincidence spectrometer is designed for detecting only gamma rays converted by the Compton process. The spectrometer comprises three scintillation crystals, a first detector optically coupled to all three crystals, a second detector coupled to the first crystal, a third detector coupled to the second crystal, and a measuring system responsive to the output of the first detector only when it is coincident with the outputs of the second and third detectors. An embodiment of the spectrometer is described for well logging. (D.L.C.)

1784 LINEAR COUNT-RATE METER. (to U. S. Atomic Energy Commission). British Patent 908,950. Oct. 24, 1962.

A counting-rate meter system is designed for a substantially linear output with rates from 1 up to 100,000 cps. In this system, the input pulses are fed into a discriminator and then into a trigger circuit which converts the pulses to positive pulses of uniform width and amplitude. The output from the trigger circuit is fed into a one-shot multivibrator and then into a special diode-switched, constant-current metering circuit. (D.L.C.)

1785 SYSTEM FOR DETERMINING THE RADIOACTIVITY OF GAS SOLS. Jacob H. Spaa (to Philips Gloeilampenfabrieken). Canadian Patent 641,925. May 29, 1962.

A system is designed for determining the radioactivity of aerosols above the natural background of radon and thoron. The system comprises means for collecting the aerosol particles on filter paper and alpha- and beta-counting detectors on either side of the filter, the beta detector having an absorbing filter for making the ratio between detected betas and detected alphas for the daughter products of thoron equal to that for the daughter products of radon. (D.L.C.)

1786 MONITORING DEVICES FOR DETECTING FISSION PRODUCTS IN A GASEOUS STREAM. Jean Graftieaux and René Donguy (to Commissariat à l'Énergie Atomique). Canadian Patent 648,420. Sept. 11, 1962.

A monitoring device is designed for detecting possible can bursts in gas-cooled reactors by monitoring short-lived fission products in the coolant. The device comprises a casing forming a cavity, a rotatable drum fitting closely in the cavity, electric means for producing an electric field in the casing for impelling ions against an area of the drum, a radiation detector adjacent to the electric means, and driving means for bringing successive areas of the drum first opposite the electric means and then opposite the detector. The free volume around the drum is reduced as much as possible so that parasitic radioactivity is minimized and parts operating the drum are protected from radiation. (D.L.C.)

1787 WELL TYPE IONIZATION CHAMBERS. Jacques Engelmann (to Commissariat à l'Énergie Atomique). Canadian Patent 648,907. Sept. 18, 1962.

A $4\pi\gamma$ cylindrical ionization chamber with cylindrical high- and low-voltage electrodes is designed for increased volume of uniform sensitivity. The chamber has collar means for varying the inter-electrode distance along the chamber axis. (D.L.C.)

1788 STABILIZED SPECTROMETER. Serge A. Scherbatskoy. U. S. Patent 3,056,885. Oct. 2, 1962.

A stabilized spectrometer of the scintillation type is designed. The spectrometer utilizes a stabilizing unit with a source of pilot light flashes to offset adventitious changes in photomultiplier amplification. (D.L.C.)

1789 RADON DETECTOR. Max Marie Vital Glaude and Daniel Boclet (to Commissariat a l'Energie Atomique). U. S. Patent 3,056,886. Oct. 2, 1962.

A portable apparatus is designed for indicating the radon content of the surrounding air on site, e.g., in laboratories, plants, and mines. The apparatus comprises a completely collapsible chamber with a stationary wall formed by a scintillating detector element, photomultiplier means, and means for counting the pulses. (D.L.C.)

1790 SCANNING DEVICE AND METHOD. Walton D. West (to Baylor Univ.). U. S. Patent 3,057,998. Oct. 9, 1962.

A scanning device is designed for medical diagnosis. In the use of the device for scanning a body into which a radioactive tracer has been introduced, the radiating part of the body is scanned with a scintillation counter, the pulses are converted into a visual record on a photographic film, and an x-ray record of the radiating area is also produced on the same film for reference purposes. The lamp for reproducing the pulses on the film is flashed at a sufficiently rapid rate so that all the pulses are recorded as dots on the film. (D.L.C.)

ISOTOPE SEPARATION

1791 (LS-101) ISOTOPE SEPARATION METHODS. An Annotated Bibliography. M. Gazith (Israel. Atomic Energy Commission, Rehovoth). June 1962. 152p.

A bibliography on isotope separation is presented covering the period 1922 to 1961; however, in the section on thermal diffusion some applications to nonisotopic systems are included. The 498 references are arranged within sections by year of publication or declassification, then alphabetically according to author. The following topics are used as sections: bibliographies, reviews and theory, gaseous diffusion and porous membranes, thermal diffusion theory and applications, gas centrifuge and separation nozzle, and chemical and miscellaneous methods. Author and report and patent number indexes are included. (M.C.G.)

1792 (MLM-1088(Suppl.)) SUPPLEMENT TO THERMAL DIFFUSION: A BIBLIOGRAPHY. G. R. Grove—K. S. Wallach, comp. (Israel. Atomic Energy Commission, Rehovoth). July 1962. 14p.

A list of available abstract references from Chemical Abstracts for all the titles included in G. R. Grove's Bibliography on Thermal Diffusion is presented. The order of the titles is the same as for the original bibliography. The name of the first author is given. (M.C.G.)

1793 A THERMODYNAMIC STUDY OF THE TERNARY SYSTEM, TRIETHYLAMINE, WATER AND HEAVY WATER, WITH SPECIAL REFERENCE TO ISOTOPE SEPARATION PROBLEMS. C. U. Linderstroem-Lang (Danish Atomic Energy Commission, Risø, Denmark). Acta Chem. Scand., 16: 1730-50(1962). (In English)

An experimental isotope separation and solubility study in the two-phase region of the system, water ($D_2O + H_2O$)-triethylamine (TEA) was carried out. Concentrations of D_2O and H_2O in TEA were determined by their absorption at 4.0 and 6.1 μ, respectively. Diethylamine and ethylamine as impurities in the triethylamine used, were determined by quantitative paper chromatography using a modified Levy-procedure. Fundamental thermodynamic equations pertinent to the calculation of hydrogen isotope separation effects in the system at equilibrium were developed. The total water concentration, x_w, of a phase and the isotopic composition, y_D, of the water (both in mole fractions) were chosen as independent variables. It was presumed that changes in activity coefficients, f, when y_D is varied at constant x_w were small compared to changes when x_w is varied at constant y_D. On this basis it was postulated that reasonable first-order or second-order approximate relations are obtained when it is assumed that $(\partial \ln f/\partial y_D)_{x_w,T} = 0$ or $(\partial \ln f/\partial y_D)_{x_w,T}$ = a constant (independent of y_D), respectively. The relations were introduced into the fundamental equations and it is shown that in both cases a numerical calculation of the isotope separation effect can be carried through with reasonable accuracy, using available enthalpy data and/or vapor pressure data for pure H_2O-TEA together with two-phase equilibrium data for the binary systems, H_2O-TEA and D_2O-TEA. The numerical calculation indicated that $\partial \ln f/\partial y_D$ is less than 0.01 × $(\partial \ln f/\partial x_w)$. The relative solubility change of water in TEA, when H_2O is replaced by D_2O at constant temperature, $(d\ln x'_w/dy'_D)_{eq,T}$ multiplied by a factor, $Q = 1 + x'_w(\partial \ln f'_w/\partial x_w)$, expressing the degree of ideality in the triethylamine phase, was found to be a simple and convenient measure of the isotope separation effect. It is shown that the large $d\ln x'_w/dy'_D$ found in this system and in other similar systems must be compensated to a great extent by a small Q, so the absence of any high isotope separation effect is easily understood. (auth)

1794 A POSSIBLE METHOD FOR THE SEPARATION OF ISOMERIC ATOMIC NUCLEI. W. Schwertfuehrer (Osterreichische Hochschule, Vienna). Atomkernenergie, 7: 284(July-Aug. 1962). (In German)

A method of separating and enriching long-lived isomeric nuclei is proposed, the carrier material consisting of ground-level nuclei of the same isotope. The large difference in spins and magnetic moments between isomeric and ground level nuclei is to be used in the atomic beam method for getting a larger deflection of isomeric nuclei in a strong inhomogenous magnetic field. They are to be precipitated on a target in enriched form. (auth)

1795 MULTICOMPONENT ISOTOPE SEPARATION IN CASCADES. D. J. Clarke (United Kingdom Atomic Energy Authority, Cheshire, Eng.). Chem. Eng. Sci., 17: 709 (Sept. 15, 1962).

The adoption by de la Garza of a matched abundance ratio (matched R) as a mixing criterion in a three-component separation cascade is discussed. It is pointed out that there may be some operation conditions for a real cascade for which the separative power of a matched R cascade would be very different from that of the minimum power cascade. These conditions are associated with small U^{238} concentrations, and an example is given in which a matched R cascade would lead to practically no separation of U^{235} and U^{236}. (D.L.C.)

1796 MULTICOMPONENT ISOTOPE SEPARATION IN CASCADES. A. de la Garza (Oak Ridge Gaseous Diffusion Plant, Tenn.). Chem. Eng. Sci., 17: 709-10(Sept. 1962).

A reply is given to Clarke's comments on the matched abundance ratio (matched R) as a mixing criterion in separation cascades. The limitations of the matched R criterion are discussed. The matched R cascade is generalized and a new function, the key weight function, is introduced. The function involves altering the separation characteristics of three-component cascades by adding two dummy components with varying molecular weights. (D.L.C.)

1797 NEW METHODS OF ISOTOPE SEPARATION. P. G. Morgan (Univ. of Manchester, Eng.). Fluid Handling, No. 145, 30-2(Feb. 1962).

A brief description is given on the principle of operation and results achieved so far with a nozzle separation technique. Possibilities of new developments in separation methods are also included. It appears that the separation effect per stage with the nozzle technique is of the same order of magnitude as the conventional diffusion process. (P.C.H.)

1798 INDUSTRIAL PRODUCTION OF DEUTERIUM POOR IN TRITIUM. André Coulon (Office National Industriel de l'Azote, Toulouse), Léon Stouls, and Guy Simonet. Ind. At., 6: 81-93(1962). (In French)

Because of the natural presence of T_2 in hydrogen and water, D_2 extracted from these primary materials has a T_2 concentration which can become troublesome when the D_2 is utilized in a bubble chamber. Probability of parasitic phenomena caused by T_2 and of fuzziness in the photographs is increased. The distillation apparatus used for the separation of the three hydrogen isotopes at the compagnic

francaise de l'Eau lourde was improved in order to reduce the T_2 concentration of D_2. The details of this improvement are given. (tr-auth)

1799 SEPARATION OF THE ISOMERS OF Te 127 AND 129 BY PAPER ELECTROPHORESIS. J.-P. Adloff and M. Bacher (Centre de Recherches Nucleaires, Strasbourg). J. Chromatog., 9: 231-3(Oct. 1962). (In French)

A carrier-free solution of sodium tellurite is oxidized into sodium tellurate, and the system is allowed to come to radioactive equilibrium. The decay of the metastable states of Te^{127} and Te^{129} causes the Te to undergo a transition to the tellurite form. At a pH of 3, for example, 28 and 35% of the Te^{127} and Te^{129} respectively are transformed into the tellurite form under the experimental conditions used. Paper electrophoresis is used to separate the tellurite and tellurate components. The half lives of the metastable and ground-state isomers are outlined. The separation efficiency is discussed. (T.F.H.)

1800 RADIATION FROM CONDENSED HYDROGEN, CONDENSED HELIUM, AND CONDENSED NITROGEN IN HIGH VACUUM. E. W. Becker, R. Klingelhoefer, and P. Lohse (Kernforschungszentrum Karlsruhe, Ger.). Z. Naturforsch., 17a: 432-8(1962). (KFK-102). (In German)

An arrangement for production of condensed molecular beams is described which makes possible a cooling of the nozzle used in the jet production to the temperature of liquid helium. With liquid hydrogen, liquid helium, and liquid nitrogen as cooling baths, beams of condensed hydrogen, condensed helium, and condensed nitrogen were produced in high vacuum. The velocity distribution of this beam was determined by a transmission-time method. It is shown that the intensity of the condensed hydrogen beam is increased by addition of helium and the condensed nitrogen beam by addition of hydrogen. The noncondensed additions were removed from the condensed beam by the separate-nozzle effect. By use of mixtures of hydrogen and deuterium the heavier isotope was enriched in the condensed beam by about a factor of three. (tr-auth)

1801 IMPROVEMENTS IN THE SEPARATION OF LIGHT AND HEAVY COMPONENTS OF A FLUID MIXTURE. Reginald Jack Cross. British Patent 907,657. Oct. 10, 1962.

A method and an apparatus are described for the improved separation of light and heavy components, especially isotopes, of a fluid by centrifugal force. In the apparatus, the fluid is caused to form an annulus whose radius increases along its axis, and temperature gradients are also used to improve the separation. (D.L.C.)

1802 METHOD AND MEANS FOR HEAT EXCHANGE OF GASES. Bengt Eriksson (to Allmänna Svenska Elektriska Aktiebolaget). Canadian Patent 638,951. Mar. 27, 1962.

A simplified heat-exchange process is described for heating and cooling the H_2S gas used in the dual-temperature isotope exchange of deuterium between $H_2O(l)$ and $H_2S(g)$. The process comprises cooling the H_2S gas before entering the cold tower by countercurrent direct contact with cooled water, heating the H_2S gas before entering the hot tower by direct contact with heated water, and indirectly exchanging the heat between the two water streams. Thus, a complicated gas-gas heat exchange is replaced with a comparatively simple fluid-fluid heat exchange. (D.L.C.)

1803 PROCESS FOR ISOTOPIC ENRICHMENT OF LITHIUM BY CHEMICAL EXCHANGE. Eiichi Saito and Gregoire Dirian (to Commissariat à l'Énergie Atomique). Canadian Patent 641,016. May 8, 1962.

A process is given for the isotopic separation of lithium by chemical exchange between lithium amalgam and an aqueous solution of a lithium salt. In the process, the side reaction between the water of the aqueous solution and the lithium of the amalgam is made negligible either by applying a potential difference between the phases or compensating the reaction with electrolysis of the aqueous phase in another contact apparatus downstream. (D.L.C.)

1804 PRODUCTION OF DEUTERIUM-RICH WATER. August Winsel and Eduard Justi (to Accumulatoren-Fabrik A. G. and Siemens-Schuckert-Werke A. G.). Canadian Patent 641,333. May 15, 1962.

A process is given for the continuous production of deuterium-rich water from deuterium-poor water. In the process, the water poor in deuterium is passed through enrichment cells Z^1 to Z^n in countercurrent flow to a hydrogen stream and is then decomposed in an electrolytic cell Z^{el}, the electrolytic hydrogen is passed from the Z^{el} cathode through the anodes of Z^n to Z^1 to pass into solution electrochemically, and the final hydrogen evolved at the cathode of Z^1 is led off. (D.L.C.)

1805 PROCESS FOR THE PREPARATION OF HEAVY WATER. Marcel Delassus, Michel Briec, and Bertrand Lazard (to Commissariat à l'Énergie Atomique). Canadian Patent 644,705. July 10, 1962.

A process for the preparation of D_2O is given which uses the isotopic exchange of deuterium between ammonia and hydrogen. The apparatus for carrying out the process, besides the reactors for ammonia-hydrogen exchange in the presence of a catalyst and units for synthesizing ammonia and for breaking up ammonia, also includes at least one catalyst re-injection loop for concentrating the catalyst before re-injection into the ammonia in the reactors. Thus, the loss of deuterium enrichment due to catalyst recycling is prevented. (D.L.C.)

1806 METHOD FOR THE ENRICHMENT OF D_2O IN SOLUTIONS OF D_2O IN H_2O. Edward G. Shay (to Atlantic Refining Co.). U. S. Patent 3,058,811. Oct. 16, 1962.

A method for increasing the D_2O concentration in a H_2O solution is given which uses a nonionic surface-active agent having a polyalkylene glycol hydrophilic group. The method comprises adding the surface-active agent to a solution of D_2O in H_2O at a temperature below the cloud point of the agent, raising the temperature of the solution above the cloud point to form two liquid phases, and separating the phases. The upper phase contains a little of the agent and an increased D_2O concentration, while the lower phase contains most of the agent and a decreased D_2O concentration. The agent is preferably an isoöctyl phenol polyethoxy ethanol. (D.L.C.)

MATHEMATICS AND COMPUTERS

Refer also to abstract 2070.

1807 (DC-60-1-4) FREE — ANP NO. 332, EA NO. 7-1203. W. R. Strong (General Electric Co. Aircraft Nuclear Propulsion Dept., Cincinnati). Dec. 21, 1959. Contract [AT(11-1)-171]. 67p.

A program is described which is used to calculate the undamped natural frequencies and mode shapes of structural systems using up to 115 degrees of freedom. The input data consists of matrices of the mass and spring constants which describe the system. (auth)

1808 (KAPL-M-EPS-2) ON THE NUMERICAL SOLUTION OF CERTAIN COUPLED PARTIAL DIFFERENTIAL EQUATIONS. E. P. Shelly (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 6, 1962. Contract W-31-109-eng-52. 16p.

If relative to the variable E a Rayleigh-Ritz technique is used on the equation (i) $-\nabla\cdot d(x,E)\nabla F(x,E) + L(x,E)F(x,E) + \int_0^\infty g(x;E',E)F(x,E')dE' = s(x,E)$, then the system of partial differential equations (ii) $-\nabla\cdot D(x)\nabla\Phi(x) + K(x)\Phi(x) = S(x)$ must be solved. Of greatest interest is a class of realistic physical problems for which the matrices D(x) and K(x) are positive definite for each x of the domain of equation (i). The solution of a finite difference system analogous to (ii) and a convergence theorem for an iterative method used to obtain the finite difference solution are presented. (auth)

1809 (LADC-5539) MULTIPARAMETER ANALYZERS AT THE LOS ALAMOS SCIENTIFIC LABORATORY: EQUIPMENT AND TECHNIQUES FOR DATA REDUCTION AND ANALYSIS. R. H. Moore (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract [W-7405-eng-36]. 29p.

Computing and auxiliary equipment and its utilization in the preparation of useful analyses of multiparameter experimental data are discussed. Extensive illustrative use is made of data obtained from experiments in which measurements were made of the energies of two coincident fission fragments using semiconductor detectors. The S-C 4020 microfilm recorder is employed to display contours of such data. The multivariate normal (Gaussian) density function is suggested as a useful expression for representing these data. (auth)

1810 (MND-C-2500-1) ARMY PRESSURIZED WATER REACTOR CODE. Final Summary Report. T. M. Olsen (Martin-Marietta Corp. Aerospace Div., Baltimore). June 1962. Contract AT(30-1)-2431. 199p.

The APWRC is basically a one-dimensional reactor physics neutron code, although synthesis options are provided. The information is presented to summarize the APWRC physical model in terms of its supporting machine programs, and their uses, limitations, and requirements. The automated combination of the individual codes pertaining to the overall APWRC is described. The APWRC consists of the following: CELCOR, multigroup cell heterogeneity corrections; SYNFAR-02, multigroup-multiregion moderation calculations with coupled few-group spatial transport for flux distribution and reactivity; GAMICO, few-group microscopic library of burnup cross sections; and SYBURN, few-group spatial transport burnup. The report is meant to serve as a workbook and operating manual for these programs. (J.R.D.)

1811 (MURA-645) COMPUTER PROGRAM FOR BEAM TRANSPORT PROBLEMS. D. A. Swenson (Midwestern Universities Research Assn., Madison, Wis.). July 20, 1962. Contract AT(11-1)-384. 18p.

A computer program, entitled BEAM TRANSPORT, which was written to facilitate the study of beam transport systems is described. The program was written in Fortran for an IBM 704 computer with a 32K fast memory and at least one tape unit. The program simulates the action of each element of a beam transport system on a group of charged particles representing a beam. The high speed and flexibility of this approach provide a tool for the design of transport systems, as it is practical to evaluate the performance of many "imperfect" systems in the process of adjusting the parameters of the transport system to obtain a more satisfactory one. (auth)

1812 (NAA-SR-6727) CROCK AND SHOCK: FORTRAN CODES FOR OPTIMIZATION OF HEAT-REJECTION SYSTEMS FOR SPACE POWER PLANTS. R. A. Stone, R. H. Shudde, and H. L. Friedman (Atomics International, Div. of North American Aviation Inc., Canoga Park, Calif.). Nov. 1, 1961. Contract AT(11-1)-Gen-8. 40p.

The computer codes CROCK and SHOCK, written to aid power system designers in selecting the minimum weight point for space power plant radiators, are described. CROCK can be used to select the minimum weight design for a system in which the waste cycle heat is radiated directly to space from the condenser, while SHOCK can be used for systems in which the sensible heat lost from a single-phase fluid is radiated. (J.R.D.)

1813 CONSTRUCTION THEORY OF THE INHOMOGENEOUS LORENTZ GROUP AS FUNDAMENTALS OF QUANTUM MECHANICAL KINEMATICS. Hans Joos (Universität, Hamburg). Fortschr. Physik, 10: 65-146 (1962). (In German)

The construction of the inhomogeneous Lorentz group is discussed from the viewpoint of relativistic kinematics, within the limitations of the construction with the characteristic invariants $P_\mu P^\mu > 0$. The construction given depends essentially on an explicit calculation of Wigner considerations. The problem of reducing this construction of the homogeneous Lorentz group is solved, explicitly for the construction of the inhomogeneous group, by a transformation from the canonical basis to another basis into which the construction operators of the homogeneous Lorentz transformation is decomposed. The analogs to the Clebsch-Gordon series for the product construction of the rotational group were determined for the product of the two irreducible constructions of the inhomogeneous Lorentz group. (J.S.R.)

1814 CONCEPTION OF A NEW ENSEMBLE FOR MULTIDIMENSIONAL ANALYSIS. J. C. Brun, G. Verroust, and C. Victor (Laboratoire Joliot-Curie de Physique Nucleaire, Orsay, France). J. Phys. Radium, 23: Suppl. to No. 6, 129A-33A(June 1962). (In French)

After showing the importance of multidimensional analysis in nuclear physics, the general principles of the equipment performing this type of analysis are outlined. These principles were applied to the design of a 100,000 channel, multidimensional analyzer, being constructed in the Laboratoire Joliot-Curie de Physique Nucléaire de la Faculté des Sciences d'Orsay. This equipment, designed around an IBM 1620 computer can be adopted to a great number of experiments involving multiple correlations. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

Refer also to abstract 1627.

1815 (ANL-6314) CERAMIC NUCLEAR FUELS IN THE SYSTEM ZrO_2–CaO–UO_2. Final Report. J. H. Handwerk, G. D. White, and D. C. Hill (Argonne National Lab., Ill.). Sept. 1962. Contract W-31-109-eng-38. 15p.

Potential nuclear fuels in the system ZrO_2-CaO-UO_2 were investigated. Cubic fluorite-type solid solutions, as indicated by x-ray diffraction patterns, were formed by sintering CaO-stabilized ZrO_2 and U_3O_8 compacts in either air or H_2. A continuous solid solution was found between urania and stabilized zirconia with H_2 sintering at 1750°C. Air sintering produced a limited region of solid solution in the stabilized zirconia portion of the system at 1450°C. Results on phase identification, oxidation behavior, and water corrosion are presented. (auth)

1816 (BMI-X-10016) DEVELOPMENT OF NIOBIUM-BASE ALLOYS FOR USE IN A NUCLEAR SUPERHEATER. Quarterly Progress Report, July-September 1962. John A. DeMastry and Arthur A. Bauer (Battelle Memorial Inst., Columbus, Ohio). Oct. 1, 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract W-7405-eng-92. 9p. (EURAEC-467)

Progress is reported on the development and evaluation of several Nb-base alloys resistant to corrosion by steam. (R.J.S.)

1817 (LADC-5471) MULTIKILOGRAM ELECTROREFINING OF PLUTONIUM METAL. L. J. Mullins and J. A. Leary (Los Alamos Scientific Lab., N. Mex.). Oct. 17, 1962. Contract [W-7405-eng-36]. 11p.

Fused salt electrorefining processes were developed for producing high purity, high density plutonium metal on the 3.5-kg scale. The refined metal, which is collected as a liquid on a tungsten cathode, drains continuously into a reservoir where it is collected as a batch casting. Product collection yields are greater than 95%. The electrolyte consists of an equimolar mixture of NaCl–KCl containing either $PuCl_3$ or PuF_3. A magnesia–yttria cell contains the fused salt and liquid metal. The electrolyte and liquid anode are stirred by a ceramic stirrer to avoid polarization effects. (auth)

1818 (UCRL-6997) BIBLIOGRAPHY OF MATERIALS PLATING BY THERMAL DECOMPOSITION OF GASES OR VAPORS. Charles P. Coughlen (California. Univ., Livermore. Lawrence Radiation Lab.). June 28, 1962. Contract W-7405-eng-48. 10p.

Eighty-three references are given on the plating of materials by thermal decomposition of gases or vapors. The search covered the period January 1958 to April 1962. The references are presented in three groups: technical references, patent literature, and trade journals. (M.C.G.)

1819 (AEC-tr-5496) IMPROVEMENTS IN THE PROCEDURE OF ELECTROPLATING METALS, PARTICULARLY URANIUM BARS FOR NUCLEAR REACTOR FUEL ELEMENTS. F. Brossa and M. Airola. Translated by Myra S. Feldman (Savannah River Lab., Aiken, S. C.) from Belgian Patent 600,262. Feb. 16, 1961. 5p.

A process is described for electroplating U with well-adhering Ni coatings. The U surface is electrolytically cleaned, water washed, and electro-coated. The diffused corrosion barrier thus formed is applicable to reactor fuel plates. (J.R.D.)

1820 (AEC-tr-5497) IMPROVEMENTS IN THE APPARATUS FOR CLEANING AND ELECTROPLATING OF METALS, PARTICULARLY URANIUM BARS FOR NUCLEAR REACTOR FUEL ELEMENTS. F. Brossa and D. Tytgat. Translated by Myra S. Feldman (Savannah River Lab., Aiken, S. C.) from Belgian Patent 600,263. Feb. 16, 1961. 6p.

An apparatus is described for cleaning and electroplating cylindrical metallic objects. The cylindrical object is fastened to an oscillating mechanism which causes it to revolve on a support so that its position in relation to the electrodes is continually changed and optimum conditions are realized to obtain uniform corrosion and plating of its surface. The apparatus is particularly, but not exclusively, applicable to the preparation and coating of U fuel elements. (J.R.D.)

1821 (AEC-tr-5533) ELECTRODEPOSITION OF METAL FROM SOLUTION IN ORGANIC SOLVENT. Yoshizo Takeda. Translated for Westinghouse Electric Corp., Bettis Atomic Power Lab., Pittsburgh from Kinzoku, 29: 923-8(1959). 21p.

Methods are being developed for electrodeposition of metals that resist electrodeposition from aqueous solution. Results are described in experimental use of organic solvents. (R.J.S.)

1822 (JPRS-15907) THE USE OF ZIRCONIUM AND ITS COMPOUNDS IN INDUSTRY. Translation of "Primenenie Tsirkoniya i ego Soedinenii v Promyshlennosti" (a publication of the Academy of Sciences, Ukrainian SSR Publishing House, Kiev, 1962, p.1-100). 110p.

Results of research on the production of infusible compounds of zirconium and on the use of zirconium concentrate, iron-free zircon, zirconium, zirconium dioxide, and zirconium alloys in the refractory, glass, electrochemical, metallurgical, and chemical industries are surveyed. Materials from the Ukrainian conference on the use of zirconium and its compounds are included. The following topics are covered: basic physico-chemical properties of zirconium, its compounds, and alloys; use of zirconium and its compounds in the production of hard and refractory alloys; producing alloys of zirconium for ferrous metallurgy; zirconium in construction steel, uses of zirconium in the electro-vacuum industry; use of casting materials based on zirconium mixtures and paints; technology of manufacturing forms and cores using zirconium mixtures, pastes, paints, and parting media; use of foundry paint based on zircon in casting production; technico-economic indices of casting production using zirconium-coated casting forms; use of zirconium dioxide in the production of electro-condensers; fields and possible levels for the use of zirconium-containing refractories; use of zirconium raw material in the production of electro-smelting refractories for the glass industry; and use of zirconium compounds in the production of enameled dishes. (M.C.G.)

1823 (JPRS-15978) NIOBIUM AND ITS ALLOYS—USE OF POWDER METALLURGY IN THE USSR. G. V. Zakharova, I. A. Popov, L. P. Zhorova, and B. V. Fedin. Translation of parts of "Niobii i ego Splavy" (a publication of the State Scientific and Technical Publishing House for Literature on Ferrous and Nonferrous Metallurgy, Moscow, 1961). 47p.

Topics covered by the translation include: production of powdered metallic niobium, obtaining compact niobium, obtaining compact niobium by means of powder metallurgy,

physico-chemical processes in the smelting and sintering of metals in a rarefied atmosphere, Nb–Be alloys, Nb–B systems, Nb–Si systems, Nb–Cr alloys, Nb–V–Ti alloys, Nb–W–C systems, Nb–Mo–Ti alloys, and Nb–W–Ti–C systems. (M.C.G.)

1824 METHOD FOR THE PREPARATION OF REACTOR FUEL ELEMENTS. M. Steenbeck. German Patent DWP 21948. Sept. 16, 1961. Kernenergie, 5: 584(July 1962). (In German)

In the preparation of fuel elements with random grain sizes in a carrier metal melt, the wettability of the fuel element particles with respect to the carrier metal melt presents great difficulties. These were overcome when molecular hydrogen was led through an especially high frequency electric arc for the purpose of transforming the molecular hydrogen largely into atomic hydrogen. Then the atomic hydrogen was led to the carrier metal melt, at the surface of which are found the fuel particles introduced into the melt for deoxidizing and protecting the system against further oxidation. Finally the fuel particles were wet and surrounded by the carrier metal melt. (J.S.R.)

1825 NEW REFRACTORY FIBERS FOR ABLATION, THERMAL INSULATION. J. P. Sterry. Materials in Design Eng., 56: No. 4, 12-13(Oct. 1962).

Refractory oxide fibers of zirconia and zircon are now being produced in the form of wools and batts. The fibers may be laminated and impregnated, and they are useful for reinforcing ablation materials and for use as thermal insulation. The properties of the fibers are described, and the types of fibers available are outlined. (D.L.C.)

1826 REFRACTORY METALS ROUNDUP. M/DE Special Report No. 200. Donald Peckner. Materials in Design Eng., 56: No. 4, 131-46(Oct. 1962).

Alloys of the six metals Mo, Ta, Nb, W, Cr, and V are treated individually. Developments, properties, and new alloys are discussed. A table for refractory alloy sheet selection is presented. Finally, fabrication of these metals is discussed. (D.L.C.)

1827 ELECTROLYTIC DEPOSITION OF UNIFORM AND SOLID URANIUM OXIDE LAYERS ON ALUMINUM. Hans-Otto Denschlag and Guenter Herrmann (Universität, Mainz). Nukleonik, 4: 277-9(Oct. 1962). (In German)

Uniformly thick and solidly adhering uranium oxide layers on aluminum up to ~7 mg/cm^2 were obtained with almost quantitative yield by electrolysis of weakly and uranyl nitrate solutions. Non-uniform layers could be detected by a low specific alpha count rate. (tr-auth)

1828 FUSED-SALT SCRUBBING OF ZIRCONIUM TETRACHLORIDE. D. R. Spink (Carborundum Metals Co., Akron, N. Y.). Trans. Met. Soc. AIME, 224: 965-70(Oct. 1962).

In the preparation of zirconium and hafnium metals, there are many indications that impurity levels control the physical and chemical properties of the metal. Methods of producing pure raw materials that could be reduced to highly pure metals were developed. Early work indicated that certain fused salts were highly efficient in the removal of impurities from gaseous zirconium tetrachloride. Workable fused salts were developed along with a continuous and highly efficient scrubber design which can be used to produce very pure zirconium tetrachloride. Metal made from the purified tetrachloride is shown to approach crystal bar metal in purity. Scrubber designs are discussed with recommended materials of construction. (auth)

1829 POWDER METALLURGY IN THE NUCLEAR AGE. Plansee Proceedings 1961, held June 20-24, 1961, Reutte/Tyrol. F. Benesovsky, ed. Reutte/Tyrol, Austria, Metallwerk Plansee AG., 1962. 835p.

Papers presented at the Fourth Plansee Seminar "De Re Metallica" on powder metallurgy in the nuclear age are given. Separate abstracts were prepared for 37 of the 40 papers. Three were previously abstracted for NSA. (M.C.G.)

1830 REQUIREMENTS FOR METALS IN NUCLEAR ENGINEERING APPLICATIONS. H. H. Hausner (Brooklyn Polytechnic Inst.). p.22-31 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

Requirements for fuel materials, cladding materials, coolants, moderators, control materials, and shielding and reflector materials are discussed. The effects of radiation on solids are described. Variables on which the radiation effect depend are listed. Methods for minimizing radiation effects are outlined. (M.C.G.)

1831 FABRICATION OF URANIUM POWDER IN A PILOT PLANT. E. Le Boulbin and P. Jabot (Centre d'Études Nucléaires, Grenoble, France). p.32-43 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In French)

The processes used, and products obtained, in a pilot plant for the daily production of about 10 kg uranium powder are described. The powder is prepared by calciothermic reduction of the dioxide according to $UO_2 + 2Ca \rightarrow U + 2CaO$; $\Delta H = -47$ kcal/Mol at 298°K. The reaction must be initiated by heating to about 740°C; once started, however, it proceeds without further heating since the heat of reaction suffices to increase the temperature above the melting point of uranium. In the reaction product, the metal is distributed in the form of small spheres within a refractory skeleton of calcium oxide. The calcium oxide and the excess calcium are dissolved in cold acetic acid, which leaves the uranium powder essentially unattacked. After separation from the calcium acetate solution, spherical powder remains, the yield being about 95%. This powder is pyrophoric; can however, be handled after appropriate protective treatment. The uranium powder has an average particle diameter of 20 micron. The impurities are oxide (0.5 to 1%), nitride (0.5%), and hydride (1 to 3%). The metallic impurities differ very little from those of the oxide starting material. The powder is a good starting material for the preparation of fuels such as carbides, silicides, nitrides, and various cermets produced by techniques of powder metallurgy. (auth)

1832 POWDER METALLURGY STUDIES INVOLVING PLUTONIUM. M. J. F. Notley, J. M. North, P. G. Mardon, and M. B. Waldron (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.44-55 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

Two widely separated powder metallurgy projects, both of which however involve the use of plutonium, are considered. The small scale preparation of plutonium powder and experiments on the compacting and sintering behavior of the product are described. Work on the fabrication of small samples of PuO_2–UO_2 solid solutions dispersed in a stainless steel matrix is also discussed. In preparing plutonium powder by the hydride route, great care was necessary to prevent oxygen contamination of the product; all handling was carried out under high purity argon (20 p.p.m.). Comparison of cold compacting and sintering with hot pressing techniques showed the latter method to be superior, especially when the load was maintained during cooling after pressing in the δ phase; the density thus achieved was 19.1 g./cm^3 as compared with values of 19.3 to 19.5 g./cm^3 for

as-cast metal. A possible explanation of this behavior based on the differences in density and plasticity between the γ and δ phases of plutonium is discussed. The importance of the PuO_2-UO_2/stainless steel cermet as a potential fast reactor fuel is outlined and the preparation of small samples by cold compacting and sintering described. The effect of variables such as load, time of sintering and repressing and sintering is detailed and some observations on the effect of sintering temperatures in the range 1300 to 1400°C are discussed. Hot pressing at 950°C was shown to give higher densities than cold pressing and sintering. (auth)

1833 MANUFACTURE OF THORIUM METAL POWDER FOR BREEDING ELEMENTS. G. Schneider (NUKEM, Nuklear-Chemie und -Metallurgie G.m.b.H., Wolfgang bei Hanau, Deutschland, Ger.). p.56-62 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In German)

The quest for the simplest possible way of manufacturing thorium breeding elements is discussed. Since the technically most important reduction processes yield thorium in the form of a powder or sponge, processing by means of powder metallurgy appears indicated. It is possible to compact thorium powder by conventional procedures to shaped bodies which are so dense that subsequent sintering is not required. This is explained by the fact that thorium exhibits an usually strong tendency toward cold welding. To utilize this advantage it is, however, necessary to avoid the undesired seizing of the powder to the walls of the pressing dies. This can be accomplished simply by interposing metal foils between powder and die walls. Aluminum foil proved to be compatible with the common die materials. The aluminum can be left on the compact surfaces since the only effect on the nuclear purity of thorium is an increase in the boron equivalent amounting to 0.14 ppm. (auth)

1834 NEW DEVELOPMENTS CONCERNING URANIUM OXIDES. R. Delmas (Centre d'Études Nucleaires, Grenoble, France). p.63-71 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In French)

The preparation of uranium dioxide powder was investigated in different batch-type and continuous furnaces, particularly in a rotary-tube laboratory furnace. Uranium trioxide obtained by calcining ammonium uranate at 380°C was reduced in this furnace by cracked ammonia at 680°C; the resulting powder had a specific surface (B.E.T.) of 4 m^2/g. and represented an excellent starting material for sintering in a reducing atmosphere. It is also possible to prepare in this rotary-tube furnace a uranium dioxide powder of high reactivity, with a specific surface higher than 10 m^2/g. The pyrophoricity of these powders in air can be suppressed by protective methods. Heat shock sintering of highly reactive powders under special conditions makes it possible to obtain sintered bodies of high density. (auth)

1835 ON CERAMIC AND SWAGEABLE UO_2. H. Doi, A. Takashima, Y. Suehiro, and T. Ito (Mitsubishi Metal Mining Co., Ltd., Omiya, Japan). p.83-115 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

As important physical properties of ceramic UO_2 powder produced by ADU method, specific surface area, oxidation behavior, and crystallite size were investigated in parallel with electron microscopic observations. Their dependence upon variables in preparation procedure was investigated. Study on UO_2 powders for swaging, produced by high temperature reduction of UO_3 was next carried out. Major factors affecting their physical properties were examined in detail by following the change of ADU precipitate to UO_2 powder. Optical and electronoptical microscopy were extensively carried out together with other measurements. The following results were obtained. Specific surface area and oxidation behavior of ceramic UO_2 powder prepared by low temperature (<900°C) calcination and reduction from ADU generally depended not only upon calcination temperature, but upon reduction temperature. However, reactivity of UO_2 powder towards oxidation was not determined by its specific surface area alone, but depended upon its surface state as well. Crystallite size of ceramic UO_2 powder was generally determined by reduction temperature and crystallite size of parent higher oxide. Use of single crystal platelet of U_3O_8 in size range of 1 to 10μ as a sample for electron-optical study revealed that shape of U_3O_8 was in general maintained throughout reduction. However, new surfaces appeared as the result of crack formation. Grain growth and densification of UO_2 powder for swaging was affected by the progress of free sintering of oxide particles during calcination and reduction. Characteristics of ADU precipitate had a dominant effect upon the progress of free sintering. By choice of preparation procedure, it was possible to produce ceramic UO_2 powders either with excellent sinterability (97% T.D./1500°C) or with small shrinkage (<12% radial shrinkage at 95% T.D./1600°C) and small shape deformity during sintering. Swageable UO_2 with tapped density as high as more than 75% was easily produced by high temperature reduction ($\geq$1500°C) of UO_3. (auth)

1836 INVESTIGATION OF THE SYSTEM UO_2-ZrO_2. E. Gebhardt and G. Elssner (Max-Planck-Institut für Metallforschung, Stuttgart). p.133-9 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In German)

The structure of the UO_2-ZrO_2 system was studied. Lattice parameters were determined. The transformation course in the region of ZrO_2 mixed crystals is shown. The influence of gain size and temperature on the solution structure of pressed UO_2-ZrO_2 was investigated. (M.C.G.)

1837 THE SINTERING BEHAVIOUR OF MIXED UO_2 AND PuO_2 POWDERS. J. D. L. Harrison, E. Foster, and L. E. Russel (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.140-65 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

Investigations were made into the sintering behavior of mechanically mixed PuO_2 and UO_2 in the composition range rom 0 to 25% PuO_2. The density, oxygen-to-metal ratio, nd the degree of solid solution attained were measured and correlated with the experimental variables. The variables were: Pu/U ratio, sintering atmosphere, sintering temperature, sintering time, compacting pressure, amount of binder added to powders, method of preparation of PuO, and ball-milling of the mixed powders prior to pressing. (auth)

1838 EFFECT OF OXYGEN ON SINTERING OF OXIDES. G. C. Kuczynski (Univ. of Notre Dame, Ind.). p.166-71 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

Recent experiments on sintering of Al_2O_3, Fe_2O_3, and ZnO revealed that the oxygen present in the ambient atmosphere may increase significantly the apparent diffusion coefficients in oxides and thus increase appreciably the sintering rates. This is probably due to the increase of the point defect concentration in the surface layer; due to the oxygen adsorption. This effect increases the diffusion coefficients in the presence of defect gradients existing in the necks between the particles or around the small pores. (auth)

1839 SIZE SENSITIVITY OF THE TWO-PARTICLE SINTERING MODEL. R. T. De Hoff, D. H. Baldwin, and F. N. Rhines (Univ. of Florida, Gainesville). p.171-9 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

An experiment using high-purity copper wire showed that the rate component in the two-particle sintering model relationship varies with size. Its values cover a range that extends beyond values predicted for any mechanism previously considered. Densification motion, consisting of the particles moving bodily toward their mutual center of mass, was observed in the two-particle case and was the more pronounced the smaller the particle. It was concluded from the extreme range of values of the rate exponent, that no specific transport mechanism can be identified through the two-particle relationship. (M.C.G.)

1840 THE INFLUENCE OF POWDER CHARACTERISTICS AND FURNACE ATMOSPHERES ON THE SINTERING BEHAVIOUR OF UO_2. V. K. Moorthy and S. V. K. Rao (Atomic Energy Establishment, Trombay, India). p.181-97 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

It was felt that if the precipitation conditions of ammonium diuranate could influence the characteristics of the UO_2 particles prepared from it, the preparation of UO_2 by decomposition and reduction of uranyl organic compounds would result in a greater divergence in the powder characteristics. In the compounds studied, it was found that the crystallite size of the UO_2 bears a relation to the compound from which it is derived; the lower the uranium content in the compound, the smaller the crystallite size of the resulting UO_2. Though the particle sizes of the UO_2 were of the same order, the sintering temperatures were lowered with a decrease in the crystallite size of the material. The atmosphere during sintering did exert an influence on the degree of densification, the rate of the crystal growth, and the texture of the sintered sample. Compared to argon, hydrogen atmosphere was beneficial for promoting sintering in fine crystallite size materials though in the coarser crystallite material, the difference was not so pronounced. The closed porosities were lower in hydrogen atmosphere than in argon. The optimum sintering temperature was reduced considerably with a decrease in crystallite size. Thus UO_2 prepared from the tannate (0.013 microns) sintered best around 1200°C compared to UO_2 from ADU (0.04 microns) at 1500°C. A sintering temperature much higher than the optimum was detrimental to the development of high density. An increase in soaking time near about the optimum sintering temperature promoted densification. It was found that urania derived from uranyl tannate can be sintered to over 98% theoretical density at a sintering temperature of 1100°C in six hours. The optimum conditions of sintering for UO_2 derived from other compounds were somewhat different, but bear a relation to the crystallite size. (auth)

1841 FISSION PRODUCTS IN SEMI-HOMOGENEOUS REACTOR FUEL. E. Nishibori, R. Ueda, S. Yajima, S. Ichiba, Y. Kamemoto, and K. Shiba (Japan Atomic Energy Research Inst., Ibaraki-ken). p.198-230 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

The basic concept of the semi-homogeneous fuel reactor (SHR) is the utilization of a semi-homogeneous fuel element composed of pellets and graphite sheath. In the pellets, powdered oxides or carbides of fissionable and fertile materials are dispersed in the graphite moderator. In a semi-homogeneous fuel, the fragments that are produced from uranium dioxide are left in a UO_2 particle, captured by graphite surrounding the UO_2 particle, or captured in the next UO_2 particle through the graphite moderator by fission recoil energy. The distributions of the fission products in the fuel are dependent on the particle size of the UO_2 powder, distribution of the UO_2 powder in the graphite moderator, and the weight ratio of graphite to UO_2. The changes in the amounts of the fission products remaining in UO_2 with the particle size was studied. It was shown experimentally that, when the weight ratio of graphite to UO_2 is greater than 30, more than 90% of the fission products is captured by graphite. Uniformity of the distribution of the UO_2 powder in the moderator was investigated by the following methods: the comparison of the radioactivity of the fission products that dissolve, together with UO_2, in nitric acid with that remaining in graphite; the radiography of a thin disc of a UO_2-graphite mixture; and the autoradiography of a UO_2-graphite pellet activated by neutrons in the JRR-1 (reactor). The diffusion of the fission products captured in graphite varied markedly with the kind of graphite used. The amount of fission products that diffused from natural graphite in a certain period of time at a constant temperature was remarkably greater than that from artificial graphite. The diffusion of the fission products captured in graphite should not be treated as a simple diffusion following Arrhenius' equation. (auth)

1842 INDUSTRIAL METHODS OF FABRICATION OF DENSE URANIUM MONOCARBIDE. A. Accary and R. Caillat (Centre d'Études Nucléaires, Saclay, France). p.231-48 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In French)

None of the procedures for the preparation of formed parts of uranium monocarbide or uranium-carbon alloys such as normal sintering, hot pressing, or arc melting allows a direct utilization for large scale production because the parts do not meet the desired demands or the costs are too high. A systematic examination of the various methods was conducted. Two procedures resulted from this study: sintering by direct resistance heating of parts obtained after reaction sintering and continuous electron beam melting. Comparative investigations about the behavior of U-UC-cermets at a thermal treatment above 1600°C, which were obtained by reaction sintering with and without pressure ed to the latter method for the preparation of dense and heat-stable products. Concerning the production of formed parts by melting, electron-beam melting makes it possible to prepare parts of uranium monocarbide continuously in one step of operation. A cooled crucible with a bottom which can be lowered is used in this case. A thin carbide layer is kept liquid on the surface of the ingot while uranium monocarbide powder is added continuously to the apparatus. (auth)

1843 PHASE DIAGRAMS OF URANIUM MONOCARBIDE-TRANSITION METAL SYSTEMS — THE SYSTEMS UC-Cr, UC-Fe, UC-UFe_2, AND UC-Ni. G. Briggs, J. Barta, and J. White (Univ. of Sheffield, Eng.). p.249-78 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

The thermal equilibrium diagrams of the systems UC-Cr, UC-Fe, UC-UFe_2, and UC-Ni were investigated. Powdered mixtures of UC and the metal, or of uranium, carbon, and the metal, were cold-pressed to form pellets and heated in thoria-lined crucibles in an atmosphere of purified argon,

until equilibrium was reached, at temperatures between 1000 and 2000°C. The fired specimens were then cooled and examined metallographically and by x rays for phase identification. Solidus and liquidus temperatures were also determined for selected compositions by metallographic examination of pellets which were fired at various temperatures. Crystals that were formed by freezing from the liquid phase could usually be distinguished quite readily from undissolved particles of the original mixture, provided that the phases present in the latter were compatible in the phase rule sense so that no reaction in the solid state occurred. Both the temperature of initial melt formation and the temperature of complete melting could thus be established within reasonable limits. (auth)

1844 PREPARATION AND PROPERTIES OF URANIUM MONOCARBIDE. D. J. Brown and J. J. Stobo (C. A. Parsons and Co., Ltd., Newcastle upon Tyne, Eng.). p.279-93 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

The cold pressing and sintering of uranium and carbon powders was shown to be capable of producing compacts of UC with densities above 80% of theoretical and with about twice as much closed as open porosity. A study of the factors influencing densification led to the conclusion that the oxygen content of the compacts is of prime importance; it should be low in order to produce high density at 1050°C and at higher temperatures a surface densification phenomenon which closes pores is attributed to reduction of uranium oxide to form liquid uranium. Arc melting and casting is shown to be a feasible method of producing simple shapes in 99% dense UC with control of carbon content within ±0.1 wt % but with some tungsten pick-up. Oxidation rates of UC in air and CO_2 are reported and excellent compatibility in liquid sodium is confirmed. Hot hardness measurements show that UC undergoes considerable softening on heating to 1000°C. Thermal conductivity measurements at 250°C show that the presence of 5 vol.-% of uranium in 4.5 wt % C material causes an unexpectedly large rise in conductivity from 0.055, the stoichiometric value to 0.061 cal/cm.°C sec. (auth)

1845 INVESTIGATION ON THE PREPARATION OF URANIUM CARBIDE AND PRODUCTION OF FUEL ELEMENTS. P. Himmelstein, B. Liebmann, and L. Schaefer (NUKEM, Wolfgang bei Hanau, Deutschland, Ger.). p.294-303 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In German)

Uranium carbide was prepared by reacting powder mixtures of uranium dioxide and graphite. Special attention was given to obtaining stoichiometric UC with a carbon content of 4.8 ± 0.1% by weight. These limits could be maintained by taking into account the excess oxygen content of the uranium oxide and proportioning the starting powders in accordance with the equation $UO_{2+X} + (3 + X)\ C \rightarrow UC + (2 + X)\ CO$. The reaction of the powder mixture and the formation of uranium carbide took place either in the solid state at 1600°C in a vacuum or by melting in an argon arc. Uranium carbide tablets prepared by reaction in the solid state had a density of 8 g./cm^3 (theoretical density 13.63 g./cm^3) and exhibited no weight gain upon standing in air for one week. They could be melted in the arc without difficulties. For the production of fuel elements, melted uranium carbide was ground to a coarse-grained powder. The powder was rammed into V2A-Steel tubes, which subsequently were swaged to effect a 50% reduction of cross section. The powder densities before and after swaging were, respectively, 71.5% and 90% of the theoretical density. (auth)

1846 POWDER METALLURGY OF URANIUM CARBIDE AND URANIUM NITRIDE. D. L. Keller, J. M. Fackelmann, E. O. Speidel, and S. J. Paprocki (Battelle Memorial Inst., Columbus, Ohio). p.304-28 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

An investigation was made of the preparation, cold-compacting, sintering, and hot-pressing characteristics of UC and UN powder. During vacuum sintering it was found that free uranium forms in UC by a reaction of the carbide and impurities, and in UN by dissociation and loss of nitrogen. In both cases high densities were obtained by a liquid-phase sintering process. However, neither UC nor UN powder could be vacuum sintering to a high density without a liquid phase present. On the other hand, dense bodies of both UC and UN were prepared by a particular form of hot pressing which consisted of densifying the powders while they were contained in metallic tubing which could become the fuel-element cladding. Temperatures of 1400 to 1480°C were required to consistently obtain 95% density at an isostatic pressure of 5 tsi for both UN and UC. (auth)

1847 SOME ASPECTS OF CERTAIN COMPOUNDS OF URANIUM AND THORIUM WITH CARBON, SILICON AND BORON. K. J. Matterson, H. J. Jones, and N. C. Moore (The Plessey Co. Ltd., Towcester, Eng.). p.329-63 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

The tetraborides of thorium and uranium and the diboride of uranium were prepared by direct synthesis and test specimens fabricated by powder metallurgical techniques. Some physical and mechanical properties were assessed and the effects of various gases below a temperature of 1000°C were investigated. A short review of the silicides and carbides of uranium is included. A study of hot-pressed mixtures of uranium and thorium borides with the appropriate carbide is discussed and the occurrence, preparation, and identification of a borocarbide of uranium is described. (auth)

1848 PRELIMINARY STUDIES ON THE SYSTEM PLUTONIUM–CARBON AND SOLID SOLUTIONS OF URANIUM CARBIDE–PLUTONIUM CARBIDE. R. Pascard (Centre d'Études Nucleaires, Paris). p.387-419 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In French)

The essential results of the investigation on the carbides of uranium and plutonium as well as their solid solutions are described. Equimolecular mixtures of Pu-C in contrary to the relation in the U—C system did not result in the carbide PuC, but in a mixture of $PuC_{1-x} + Pu_2C_3$. PuC_{1-x} is a defect carbide with only 89% of the lattice sites are occupied by carbon at the saturation limit. The solid solubility between UC and PuC can therefore not be continuous over the whole range. Uniform solid solutions between UC and PuC exist only at compositions with more than 36% UC. At lower UC contents, the system consists of two phases $(U, Pu)C_{1-x} + Pu_2C_3$. Certain deviations also exist with regard to the zeta phase (Pu_3C_2) in the plutonium-carbon system. The electrical resistivity of PuC (230 microhm. cm.) was appreciably higher than for UC (30 microhm. cm.). The electrical resistivity of a solid solution (U, Pu)C was 150 microhm cm. The preparation of the carbide powders was carried out by the reduction of the oxides followed by direct carburization of the metals (or hydrides) with carbon.

Excellent sintering results were obtained if the carbide powders were pure (absence of oxides or metal traces). Small additions of binder metals (0.5% Ni) allowed densities up to 98% of theoretical in the whole range of compositions. The results with (U, P)C-solid solution prepared from metal powders were superior concerning homogeneity and absence of Pu_2C_3. (auth)

1849 THE PROPERTIES OF URANIUM MONOCARBIDE FABRICATED BY DIRECT REACTION OF THE ELEMENTAL POWDERS. M. C. Regan and H. J. Hedger (Atomic Energy Establishment, Harwell, Berks, Eng.). p.420-32 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (AERE-R-3802) (In English)

Previously used methods for the preparation of uranium carbide compacts by hot-pressing, normal sintering, or sintering in the presence of auxiliary metals have certain disadvantages for technical applications. A method of preparation from the component powders was, therefore, developed whereby the sintering temperatures required do not exceed 1100°C. Special attention must be given to the selection, in particular the grain size distribution, of the starting materials, calcium-reduced uranium powder and natural graphite. In order to ensure completion of carbide formation during sintering, the temperature must be raised slowly so that the gases formed can escape from the pores. The specimens obtained (density 12.3 ± 0.1 g./cm^3, open pores 2%, isolated pores 8%) were used for measurements of thermal and electrical conductivities, hardness, and transverse rupture strength. Furthermore, the corrosion by gases and the capability of retaining fission products was tested. This capability is, on account of the isolated pores, more favorable than in normally sintered compacts. There is little effect of the type of porosity on the other properties. (auth)

1850 RADIATION PERFORMANCE AND FABRICATION ADVANCES WITH ALUMINUM DISPERSION FUEL ELEMENTS. G. M. Adamson, Jr., R. J. Beaver, and J. E. Cunningham (Oak Ridge National Lab., Tenn.). p.433-66 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

Recent advancements aimed at achieving high-performance characteristics in aluminum-base dispersion fuels for application in research reactors are described. Progress is discussed in terms of new innovations, design, fabrication techniques, and irradiation performance under conditions of high uranium burnup. Technical feasibility has been demonstrated for: loading heavy investments (upward of 65 wt % U_3O_8) into plate-type elements via the U_3O_8 + Al powder route; incorporating burnable poison into the fuel-bearing sections in an economical and reliable manner; flattening the neutron flux or radial power distribution in the HFIR reactor core by contouring or nonlinear grading of the fuel; achieving homogeneous distributions of both fuels and burnable poison; utilization of high-strength aluminum cladding material for structural rigidity; and joining involute shaped composite plates into an assembly for operation at a power density and neutron flux level of 4,000 kw/liter and 5×10^{15} neutrons cm.$^{-2}$ sec.$^{-1}$, respectively. The radiation behavior of various aluminum-base dispersion fuels is described and evaluated. The material combinations tested include U_3O_8 + Al, UC_2 + Al, and silicon-modified uranium-aluminum alloy. Burnup as high as 80% of the contained U^{235} atoms was achieved. In general, dispersions of the oxides showed little volume change, whereas, the UC_2 + Al combination exhibited gross swelling. Irradiation-induced transformation of UAl_3 to UAl_4 was noted even in silicon-modified uranium-aluminum alloys. (auth)

1851 PREPARATION AND PROPERTIES OF DISPERSION HARDENED URANIUM-URANIUM OXIDE. W. Arbiter and G. Stern (Nuclear Development Corp. of America, White Plains, N. Y.). p.467-82 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

The preparation of uranium oxide coated uranium powders is described. These powders were subsequently hot pressed and extruded, in vacuum, to form a dense, dispersion-hardened material. The extruded material was tested for hot hardness, hot bend strength, thermal cycling in the α/β temperature range, and metallography. (auth)

1852 THE MEASUREMENT OF DISTRIBUTION, SPACING, CONTACT AND CONTINUITY OF PARTICLES IN A MATRIX. J. Gurland (Brown Univ., Providence, R. I.). p.507-18 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

The spacing and contact of particles of one constituent distributed in a matrix of another phase is discussed. By area and lineal analysis of metallographic sections, the structural parameters may be determined. Spatial distribution was determined by comparison to random distribution by chi square test. The mean free distance between particles could be measured independently of size, shape, and distribution. The average nearest neighbor distance was calculated for a random distribution. The interfacial area per unit volume and the average fractional area of contact per particle could be measured independently of size, shape, and distribution. The average number of contacts of a particle with neighboring particles of the same phase could obtain uniform spheres. The degree of continuity is defined as the probability of infinitely long chains of particles in contact. This probability may be calculated from the average number of contacts per particle, assuming uniform size and random distributions. The theory is supplemented by experimental results based on the electrical conductivity of silver-bakelite mixtures. (auth)

1853 NEW DEVELOPMENTS CONCERNING THE TECHNOLOGY OF URANIUM OXIDE. R. Hauser (Compagnie Industrielle des Combustibles Atomiques Frittés, Domaine de Corbeville, Orsay, France). p.519-28 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In French)

The fabrication of bars and tubes of uranium oxide by extrusion and sintering in an atmosphere of cracked ammonia was investigated at temperatures of 1600 to 1650°C. The bars had a diameter of 15 mm and a length of 260 mm. With uranium oxide powder of high specific surface, about 7 to 8 m^2/g., and various binders such as polyvinyl alcohol, but in the absence of any other additive, sintering led to densities of 10.25 g./cm^3. By isostatic pressing, densities up to 10.3 g./cm^3 were obtained and it was expected that densities higher than 10.4 g./cm^3, which would correspond to 95% of the theoretical density of uranium oxide could be attained. The main interest in the extrusion process is based on the lower costs in comparison with customary compaction methods. The sintering of mixtures of uranium oxide and thorium oxide in air was also studied. The preliminary results permit the demonstration of the effects of different additives to thorium oxide and show the sintering performances of thorium oxide-uranium oxide mixtures prepared by different methods. Densities in excess of 97% of the theoretical value could be attained. Oxides of certain metals were added in small quantities to uranium oxide in order to increase the thermal conductivity. (auth)

1854 DISPERSED PHASES IN THE POWDER METALLURGY OF NUCLEAR MATERIALS. F. V. Lenel (Rensselaer Polytechnic Inst., Troy, N. Y.). p.529-42 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

Two types of Dispersed Phase Systems are discussed. The first type is used in nuclear fuel elements. These fuel elements, generally called dispersion type fuel elements, consist of a fissile phase dispersed in a continuous matrix of a non-fissile metal or alloy. Their principal advantage is in minimizing the effects of radiation damage in the fuel elements. The optimum size of the dispersed phase in dispersion type fuel elements is relatively coarse of the order of 40 to 100 microns. In the second type of dispersed phase systems the dispersion of the second phase is much finer with particles of micron or submicron size. Such fine dispersions of a second phase in a metallic matrix have an effect which has potential applications in many nuclear materials: they strengthen the matrix. Before individual applications of dispersion strengthening to nuclear materials are discussed, a general introduction to the phenomenon is presented. It includes a brief theoretical discussion and a description of methods for producing dispersion strengthened materials. The paper specific applications of fine dispersions for potential use in nuclear materials are discussed. One of these potential uses is in nuclear fuel elements which consist of fine dispersions in a metallic uranium or uranium alloy matrix. In these cases the dispersed phase not only strengthens the matrix, but also minimizes the swelling due to the formation of gas bubbles containing the fission products krypton and xenon under certain reactor operating conditions. Another use is in lead-base shielding materials. By using a dispersion of either lead oxide or of a finely distributed metallic phase in the lead matrix, materials having improved creep resistance may be produced. Finally, dispersion strengthened alloys have potential uses for structural components in nuclear reactors. SAP is discussed as a possible cladding material for fuel elements. Methods which were suggested for strengthening the nuclear metals zirconium and niobium by dispersing a finely divided second phase in the metallic matrix are discussed. (auth)

1855 HOT EXTRUSION OF POWDER FOR USE IN NUCLEAR REACTORS. P. Loewenstein (Nuclear Metals, Inc., Concord, Mass.). p.543-65 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962.

The hot extrusion of powders is discussed. The powder extrusion process is characterized by the short-time application of high pressure and temperature; densities close to theoretical are easily obtained. The preparation of extrusion billets and the extrusion operations are described. Special procedures are required because of the reactive nature of most of the materials used. The filled billet technique is used for the production of special shapes which could otherwise not be extruded. Applications of the powder extrusion process are described. These include the extrusion of metal-clad ceramic core elements and metal-clad elements and control rods with cores containing dispersions of oxides or carbides in a metallic matrix. Methods for the extrusion of beryllium into tubes and other shapes are described. (auth)

1856 APPLICATION OF EXTRUSION AND SINTERING OF POWDERS FOR THE FABRICATION OF DISPERSE FUEL ELEMENTS OF U–Al AND UO_2–SS. L. Meny, J. Buffet, and Ch. Sauve (Centre d'Études Nucléaires, Saclay, France). p.566-99 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In French)

The fabrication by extrusion and sintering of cladded bars and tubes with core of either uranium-aluminum or uranium oxide-stainless steel fuel was investigated. The powder mixtures are first predensified in a "pot," whereupon the sheathed compact is degassed and sealed in a vacuum by electron-beam welding. The subsequent coextrusion is performed at low temperature and with slow pressure application in the case of U-Al dispersions; and at high temperature with rapid pressure application, using the Ugine-Sejournet process, in the case of UO_2-stainless steel dispersions. The procedure permits the production of practically fully dense bars and tubes more than 1 m in length and 10 to 30 mm in diameter, the wall thickness of the tubes ranging from 2 to 5 mm. The physical and mechanical characteristics of the dispersion, as well as the mechanical characteristics of the cladded elements, were investigated as a function of the uranium content and the temperature. (auth)

1857 DEPOSITING OF PARTICLES BY METALIZATION IN VACUUM. C. Sari and E. Jonckheere (Centre d'Études l'Énergie Nucléaire, Mol-Donk, Belgium). p.600-14 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In French)

Metallic deposits from 2 to 15 μ were applied to spherical UO_2-particles. Molybdenum, chromium, nickel, and iron were used. The deposits were examined microscopically and by means of an acid leaching process. Swaging was performed on chromium coated particles, which were finely dispersed in an iron matrix. (auth)

1858 METAL BORIDES FOR CONTROL ROD APPLICATION: PREPARATION, PROPERTIES, AND RADIATION EFFECTS. A. N. Holden, E. W. Hoyt, W. V. Cummings, K. C. Antony, and D. L. Zimmerman (General Electric Co., Pleasanton, Calif.). p.615-44 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

The interest in refractory borides for control rod material is discussed in terms of their properties and structure. Details of the fabrication of rare earth borides by powder metallurgy methods are given. The physical properties of the various borides and their reactivity with metal matrices and with corrosive atmospheres are described. The results of recent radiation experience with these materials is discussed. In general, the helium retention of diborides and tetraborides are favorable compared with B_4C as a standard. Hexaborides release helium copiously. The corrosion resistance of tetraborides in water or steam exceeds the resistance of diborides or hexaborides. Radiation swelling is a problem in these materials, although the process is not understood. The most promising areas of application include the use of diborides as dispersion compounds in a metal matrix and the use of borides in massive form for high temperature gas cooled reactors. (auth)

1859 THE CONSOLIDATION OF BERYLLIUM POWDERS. A. J. Martin and G. C. Ellis (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). p.645-67 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

Several processes exist for the consolidation of beryllium powders, and these can be divided conveniently into primary consolidation techniques, and direct fabrication techniques. No one process is entirely satisfactory in all cases, and the factors that influence the choice of any particular method in practice are: the size of product required,

the number required, the intricacy of shape in the final machined component, the overall density required, the capital cost of the equipment involved, the necessity for particular strength or ductility properties in certain directions, and the ease with which recovered swarf can be reprocessed. Of all the primary consolidation techniques, vacuum hot pressing remains the one which is most used in practice, but a case can be made for the production of certain components by the direct forging of powders. (auth)

1860 SOME EFFECTS OF IRRADIATION ON BERYLLIUM. J. B. Rich and G. P. Walters (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.668-76 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

Tensile specimens of extruded beryllium were irradiated at temperatures below 350°C to a maximum fission dose of 2×10^{20} n.v.t. Effects of irradiation on room temperature mechanical properties only became noticeable at doses $>3 \times 10^{18}$ n.v.t.; at temperatures above 350°C no effect of irradiation was observed up to 2×10^{20} n.v.t. The low temperature effects were partly associated with the formation of dislocation loops 200 to 500 Å diameter and some recovery of properties is obtained by annealing above 500°C. When the loops have annealed small helium bubbles 100 Å, diameter are formed which grow at progressively higher annealing temperatures. Small changes in density, 1% decrease, due to the bubbles are observed after annealing at 1000°C. (auth)

1861 APPLICATION OF CERTAIN TECHNIQUES OF POWDER METALLURGY TO THE TRANSFORMATION OF BERYLLIUM. R. Syre, and J.-M. Logerot (Centre de Recherches Métallurgiques, Chambéry, France). p.677-91 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In French)

The classical methods of powder metallurgy are difficult to apply to beryllium for a number of reasons connected with inherent characteristics of the material. Some sintering procedures do not involve preliminary compaction so that it becomes necessary to maintain during sintering a low pressure (vacuum-hot pressing) or an elevated temperature (loose-sintering). In all these cases, the ductility of the sintered products is poor without plastic deformation although the density attained may be close to the theoretical density of the metal. Special techniques were studied in order to obtain high-density products with good mechanical properties and improved ductility. These techniques consist of combining pressure application at convenient temperatures with a plastic deformation at higher temperatures. The essential aim of these techniques is the production of semi-finished products of suitable shapes and dimensions which, with a minimum of work, can be processed to finished products (ingots, tubes, disks, and plates). The working temperatures are much lower than in other procedures and, with the use of sheathing, safety control is facilitated. The two processes which were especially studied are sintering-forging and sintering-extrusion. The semi-finished products obtained can be further processed by drawing, rolling, and close-die forging. (auth)

1862 THE USE OF PRE-ALLOYED POWDERS FOR NUCLEAR REACTOR PURPOSES. R. L. Sands and D. A. Oliver (B.S.A. Group Research Centre, Birmingham, Eng.). p.692-711 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

The production of pre-alloyed powders and the production and control of porous (permeable) materials, mainly in austenitic stainless steels, which were used extensively as filters in uranium extraction processes and in the purification of liquid-metal coolants are discussed. The different methods of compacting powders for the production of dense components are critically discussed and comparisons drawn between ordinary die-pressings and isostatically pressed material. The place of "cyclic-compacting" in relation to direct rolling from powders is noted. The sintering of pre-alloyed powders was considered and new results are presented. A comparison is presented of the physical properties attained by sample alloys produced by sintering from powders on the one hand and by the hot-working from the cast-ingot on the other. The elevated temperature properties of the sintered alloys are superior in most cases, with the one exception of hot fatigue properties where somewhat lower values are obtained. An outline of current applications of pre-alloyed powder-metal components to nuclear engineering is presented. (auth)

1863 TENSILE PROPERTIES OF REFRACTORY METALS AT HIGH TEMPERATURES. C. A. Brookes and B. Harris (Cambridge Univ., Eng.). p.712-22 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1961. (In English)

Mechanical properties of the refractory metals niobium, tantalum, tungsten, molybdenum, and iridium were measured in the range 0 to 2200°C, and their fracture characteristics observed. Up to 800°C a standard Hounsfield tensometer was used, and from 800 to 2200°C measurements were made in a carbon resistor vacuum furnace. Results are given showing the variation of ultimate tensile strength, yield stress, and elongation to fracture as a function of temperature for these metals. The mechanism of deformation and fracture was found to be similar to that of the lower melting point metals at homologous temperatures. The high temperature strength of iridium was found to compare favorably with that of tungsten, the strongest of the body-centred cubic metals, and was superior to all of them in resistance to contamination in atmospheres containing carbon and oxygen. (auth)

1864 POWDER METALLURGY MATERIALS FOR ROCKETS, MISSILES, AND SPACE VEHICLES. G. C. Deutsch and G. M. Ault (National Aeronautics and Space Administration, Washington, D. C.). p.723-49 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

Present applications for powder metallurgical products for rockets and space vehicles and the reasons for their selection are reviewed. These applications include the light metals as well as the heavy metals and cemented carbides. Specific problems where powder metallurgy offers outstanding promise are cited and the progress towards achieving satisfactory products are illustrated. Beryllium, the currently most widely used powder metallurgy material for space vehicles is discussed. The discussion includes: desirability of beryllium for heat shield and micrometeoroid protection; the state of the technology in beryllium; and future potential for beryllium. Composite materials consisting of fine particle, and fiber, dispersions are also discussed. Evidences of the advantages of these materials for achieving high strength at high temperature, for achieving high thermal conductivity without loss in strength, and for producing materials having controlled elastic modulus are cited. Some uses for these materials are given. The potential and current status of the use of sintered carbides is also discussed. (auth)

1865 CERTAIN ALLOYS OF RUTHENIUM WITH MOLYBDENUM. G. A. Geach, A. G. Knapton, and A. A. Woolf (Associated Electric Industries Ltd., Aldermaston, Berks, Eng.). p.750-8 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

Unalloyed ruthenium is normally intractable. It can form solid solutions with certain other transition metals, in particular with molybdenum. The fabrication, hot hardness, corrosion resistance, both in aqueous media and in oxygen, are reported for this alloy. A method for analyzing the alloy, which should be generally applicable to other ruthenium alloys, is described. (auth)

1866 EFFECTS OF DISPERSIONS ON THE RECRYSTALLIZATION AND DUCTILE-BRITTLE TRANSITION BEHAVIOUR OF TUNGSTEN. R. I. Jaffee, B. C. Allen, and D. J. Maykuth (Battelle Memorial Inst., Columbus, Ohio). p.770-98 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961." Reutte/Tyrol, Metallwerk Plansee AG., 1962. (In English)

Sintered tungsten-base alloys with up to 10 vol. % of fine oxide may be fabricated to strip by conventional hot working procedures. ThO_2, ZrO_2, HfO_2, Al_2O_3, and UO_2 are stable, while SiO_2 and MgO are volatilized during vacuum sintering. TiN, ZrN, HfN, TaN, HfC, TaC, and Ta_2C are not stable, with nitrogen, carbon, and titanium being evaporated in vacuum sintering, leaving the residual metallic elements. Residual tantalum and hafnium are detrimental to fabricability, but zirconium is not. Primary recrystallization temperatures are raised as much as 200°C by $ThO_2 + Na_2O$ dispersion, ZrO_2, and residual Zr or Ta. Secondary recrystallization was retarded up to over 2700°C with the $ThO_2 + Na_2O$ dispersion. The ductile-brittle transition in bending could be lowered as much as 90°C by dispersions, with $ThO_2 + Na_2O$ being the most effective. (auth)

1867 IMPROVED METHOD OF PROTECTING GRAPHITE, MOLYBDENUM OR MOLYBDENUM ALLOY ARTICLES FROM OXIDATION, DETERIORATION OR CORROSION. Wilfred Edgar Stanton. British Patent 908,181. Oct. 17, 1962.

A method is given for forming a protective coating on a solid base of graphite, Mo, or Mo alloy which is to be used at high temperatures up to and above 250°C. The method comprises flame-spraying a first coating of one or more oxides of Be, Al, Zr, Ti, and Ni and a second coating of one of these metals onto the base, and heating the second coating to its melting point to render it impermeable. A third coating of the same material as the first may also be applied as the outermost coating. Two examples of the method are given in which alumina is used as the first coating. (D.L.C.)

1868 ALUMINUM–PLUTONIUM ALLOYS. Oliver J. C. Runnalls (to Atomic Energy of Canada Ltd.). Canadian Patent 642,140. June 5, 1962.

An efficient method is outlined for producing Al–Pu alloys for reactor fuel rod assemblies without the intermediate preparation of Pu metal. The method comprises heating PuF_3 in the presence of Al at a temperature above the melting point of Al in a vacuum to reduce the PuF_3 to Pu and to alloy the Pu with Al. The resulting AlF is volatilized. Alloys containing a fraction of 1% to 80% Pu may be made in this way, and the method is also applicable to the production of Al alloys with U and Th. (D.L.C.)

Corrosion

1869 (AAEC/E-97) OXIDATION OF 2¼% Cr, 1% Mo STEEL IN CARBON DIOXIDE. A. Draycott and B. J. Fox (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Sept. 1962. 21p.

The corrosion of 2¼% Cr, 1% Mo steel in carbon dioxide was measured in the temperature range 460 to 525°C and the gas pressure range 0 to 225 psig. Adherent oxide scales of the Fe_3O_4–Fe_2O_3 type were formed under semi-static conditions together with an unidentified spinel. A Cr_2O_3 film was never formed under any conditions. Weight gain depended mainly on temperature and varied little with gas pressure, surface treatment, or water content of the gas. The relationship between weight gain and time varied between parabolic and cubic from 1.7 to 5.7 mg/cm² after 1000 hr exposure. Estimated penetration depths after 10,000 hr ranged from 6.8×10^{-4} to 18.5×10^{-4} in. In high velocity gas (150 ft/sec), weight gains varied from 0.7 to 2.0 mg/cm² after 100 hr. No scaling occurred during any experiment not involving thermal cycling. The relative thickness of the outer Fe_2O_3 layer in the scales examined was much greater under flowing gas than under semi-static conditions. It appears that the limiting temperature in reactors is 490°C; above this temperature excessive scale formation occurs. (auth)

1870 (ANL-FGF-381) EFFECTS OF OXYGEN AND SURFACE TREATMENT ON THE CORROSION OF STAINLESS STEEL IN SUPERHEATED STEAM. S. Greenberg and W. E. Ruther (Argonne National Lab., Ill.). Aug. 1962. Contract [W-31-109-eng-38]. 5p. (UAC-6814)

Exploratory corrosion tests performed with stainless steels in steam at 650°C and 600 psi to evaluate the effects of surface treatment are presented. Results are tabulated and discussed. (J.R.D.)

1871 (ANL-FGF-385) THE CORROSION OF 1100 ALUMINUM IN OXYGEN SATURATED WATER AT 70°C. J. E. Draley, Shiro Mori, and R. E. Loess (Argonne National Lab., Ill.). Aug. 23, 1962. Contract [W-31-109-eng-38]. 32p. (UAC-6817).

In oxygen-saturated distilled water at 70°C, the rate and amount of corrosion of aluminum during short exposure are influenced by experimental conditions. One effect is that contamination of the water by the reaction increases the corrosion rate. Subsequent to the first several days, the amount of corrosion varied with the logarithm of the exposure time. This behavior held for at least 180 days; it is believed to hold for as long as tests have provided reasonable data, the longest being about 650 days. These results are interpreted in terms of local film rupture and growth. A method of averaging the overall corrosion rate on the basis of cyclical local reactions was derived. (auth)

1872 (BMI-B&W-653) THE CORROSION IN BORATED WATER OF IRRADIATED AND UNIRRADIATED STAINLESS STEEL CONTAINING MINOR BORON ADDITIONS. Warren E. Berry, James H. Saling, and Frederick W. Fink (Battelle Memorial Inst., Columbus, Ohio). Dec. 14, 1959. For Babcock and Wilcox Co. Atomic Energy Div., Lynchburg, Va. 26p.

The corrosion behavior of irradiated and unirradiated stressed stainless steel containing minor natural B additions was studied in static 600°F water containing 10 g/l of boric acid. Alloys of AISI Type 304 stainless steel containing 0, 0.03, and 0.05 wt % B were investigated. Descaled metal losses after 1000 hr of exposure ranged from 6 to 30 mg/dm² for irradiated and unirradiated specimens of the alloys tested. These specimens were free of selective attack. The corrosion resistance of the alloys tested was essentially the same regardless of the irradiation dosage before corrosion (9.6×10^{19} nvt

thermal and 3.58×10^{18} nvt fast). No differences were observed in amount of attack in 600°F borated water for exposure times of 100 and 1000 hr. The attack under the test conditions appears no more severe than that reported for unstressed unirradiated austenitic stainless steels exposed to neutral or slightly alkaline high-purity water. (auth)

1873 (HW-73382) ON CHARGING ALPHA-PHASE Zr-2 WITH HYDROGEN BEYOND THE SOLUBILITY LIMIT. Interim Report R. E. Westerman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 2, 1962. Contract AT(45-1)-1350. 21p.

Specimens of $\frac{1}{8}$ in. Zircaloy-2 sheet were charged at 300°C with H_2 in excess of the 300°C H_2 solubility limit. The excess hydrogen was present as a continuous film of hydride which completely covered each specimen. The specimens were encapsulated and thermal cycled. Results of the investigation indicate that if nucleation and growth of the hydride phase occurs first at the free surface, supercharging of the bulk metal is impossible. If oxide films inhibit nucleation of the hydride at the surface, then the H_2 in solution can build up to the point where hydrides precipitate out in grain boundaries or within grains. (J.R.D.)

1874 (MSAR-62-109) EFFECT OF 1200 F SODIUM ON AUSTENITIC AND FERRITIC STEELS. Progress Report No. 24, August 1962. (MSA Research Corp., Callery, Penna.). Sept. 17, 1962. Contract AT(11-1)-765. 24p.

Results of a physical property study of type 316 stainless steel and Cr–Mo steel are presented with discussion and data concerning fatigue tests, stress rupture tests, creep tests, and tensile tests of specimens exposed to high-temperature air, He, or Na. Data are also included on analysis of Na from the test loops along with test loop design information and operational summary graphs. (J.R.D.)

1875 (TID-16888) BONUS BOILING WATER NUCLEAR SUPERHEAT REACTOR PROJECT. TASK FORCE REPORT ON CHLORIDE STRESS CORROSION OF AUSTENITIC STAINLESS STEEL. (Joint Task Force One). Apr. 13, 1962. 34p.

Chloride-induced stress corrosion cracking of austenitic stainless steel is described. Design and conditions for all fuel elements irradiated in the SADE Loop are summarized. Results indicated that under certain conditions of stress, moisture, radiation damage, and chloride and oxygen content, Type 304 stainless steel is subject to cracking after only a short exposure time. All of the cladding failures were intergranular with the exception of one case of transgranular cracking occurring near a weld. In-reactor tests were simulated in the CL-1 facility by electrical resistance heating of the specimens and by supplying steam from a conventional boiler. Results were similar to those obtained in SADE. It was concluded that concentration of chloride-containing solids on heated surfaces followed by periodic wetting of the surfaces with a film of moisture enhances the susceptibility for failure under superheat conditions. The chloride (and/or water removal) efficiency of the BONUS preheater was measured in order to determine the magnitude of the chloride corrosion problem due to carryover and deposition of chlorides on the stainless steel superheater fuel element cladding. Data indicated that a considerable fraction of the chlorides was removed when the preheater was new and clean, but little or none was removed after approximately one month of operation. (M.C.G.)

1876 (TID-17220(Pt.1)) THE CORROSION OF STEELS BY HIGH-TEMPERATURE WATER AND STEAM. FIRST PART. BEHAVIOR WITH NO IRRADIATION. Ph. Berge (European Atomic Energy Community). May 1961. 37p.

A summary of information concerning the behavior of carbon steel and stainless steel in water and steam at 350°C in radiation-free environments is presented. The kinetics of steel oxidation are examined and factors affecting corrosion are discussed. Corrosion test methods are also described. (J.R.D.)

1877 (TID-17220(Pt.2)) THE CORROSION OF STEELS BY WATER AND BY STEAM AT HIGH TEMPERATURE. SECOND PART. BEHAVIOUR UNDER IRRADIATION. Ph. Berge (European Atomic Energy Community). Feb. 1962. 37p.

A summary of work on corrosion of carbon steel and stainless steel by high-temperature water and steam in radiation environments is presented. Radioinduced modifications of aqueous environments are discussed. It is noted that secondary effects are not as serious in the case of stainless steel as in the reactions of irradiated aqueous media with carbon steel. It is concluded that numerous basic and applied studies are required in the development of reactor materials. (J.R.D.)

1878 A BASIS FOR DESIGN OF ALUMINUM ALLOYS FOR HIGH TEMPERATURE WATER SERVICE. R. L. Dillon and H. C. Bowen (General Electric Co., Richland, Wash.). Corrosion, 18: 406t-16t(Nov. 1962).

By a combination of careful attention to metal purity and controlled casting conditions, aluminum alloys were prepared which corrode in 360°C water at rates considerably lower than does X-8001. Hanford autoclave experience showed that 1.8% Fe, 1.2% Ni additions to high purity aluminum give the best combination of reproducible corrosion behavior, tolerance to silicon impurities and resistance to heat treatment damage. Careful examination of the improved alloys suggested that fine, uniform, second phase particle dispersal is essential to achieve the desired level of performance. Corrosion data for Al–1.8% Fe, 1.2% Ni were obtained for exposures of over one year. The data fit curves derived on the basis of blockage of cracks and pores by oxidation of metallic second phase particles imbedded in the oxide and a constant film loss to the system. (auth)

1879 THE STRUCTURE OF OXIDE FILMS ON ALUMINUM AFTER EXPOSURE TO HIGH-TEMPERATURE PURE WATER. J. H. Greenblatt (Department of National Defence, Dartmouth, Nova Scotia). J. Electrochem. Soc., 109: 1139-42(Dec. 1962).

The structure of the oxide films formed on aluminum after exposure to high-temperature pure water over the temperature range 150-350°C was examined after periods of exposure varying from 1 min to 7 hr. The technique used to prepare samples for examination showed up the different structural zones in the oxide by intensifying the contrast in refractive index between them. It was observed that the number of distinguishable zones increased as exposure conditions became more extreme and that the time for appearance of more than two zones was minimum with the least corrosion resistant material and maximum with the most corrosion resistant material. Columnar structures joining the outer crystalline layer to the metal surface at the site of second phase particles protruding through the metal interface were also observed. The columns also appeared to be connected to the third layer when such a layer was present. (auth)

1880 INTERCRYSTALLINE CORROSION OF ALUMINUM CONSTRUCTION MATERIALS AND ITS PREVENTION. E. Nachtigall. Korrosion, 14: 15-24(1962). (In German)

A review is given of studies on the intercrystalline corrosion of Al and its prevention. It was shown that increased purity does not limit decomposition, but only decreases the rate. Studies at high temperature indicated that even at the temperature of boiling water there is a tendency to intercrystalline corrosion and that introduction of small amounts of Mg do not improve this behavior. The effect of grain size and sample thickness on the velocity of intercrystalline corrosion was reported. The varying effects of water vapor, pH, and salt solutions on corrosion were discussed. Investigations on the prevention of intercrystalline corrosion, such as inhibitors, surface protection methods, electrolytic protection, and alloying supplements, were summarized. The results of a series of studies with annealed samples in distilled water at 150°C are discussed. (J.S.R.)

1881 THE EFFECT OF ALLOYING ELEMENTS AND OTHER ADMIXTURES ON THE CORROSION BEHAVIOR OF WORKED ALUMINUM CONSTRUCTION MATERIALS. H. Vosskuehler and H. Zeiger. Korrosion, 14: 25-30(1962). (In German)

In the corrosion of metallic construction materials the solution pressure, protective layer formation, and the existing potential difference play an essential role. The potential difference between various structural constituents were used in explaining the general surface corrosion of aluminum construction materials. A survey of the literature gave approximately the following gradation in stability: Al 99.98, AlMg = AlMgMn = AlMn, Al 99.5, AlMgSi, AlSi, AlZnMg, AlZnMgCu = AlCuMg. Potential measurements on these materials and their structural constituents showed the possibility for an unconstrained interpretation of the various stabilities. Other than the purest aluminum, the most stable materials are those with additions of Mg, Mn, or both. When attack occurs, these go into solution, but remain at the surface. Therefore the corrosion process ends without significant alterations at the surface. In the second group of materials from Al 99.5 to AlCuMg the potential difference between the basic mixed crystal and intercalations increases. The basic mixed crystal is anodic. Such corrosion attack comes from stress of the mixed crystals and explains the decreased general stability of these alloys. (tr-auth)

1882 THE CORROSION OF ZIRCONIUM AND ITS ALLOYS IN HOT WATER AND STEAM. H.-W. Schleicher (Metall-Laboratorium der Metallgesellschaft A.G., Frankfurt am. Main.). Korrosion, 14: 31-7(1962). (In German)

The corrosion behavior which zirconium and its alloys exhibit in hot water and water vapor is reported. After a brief description of the test methods, the kinetics of the corrosion of unalloyed zirconium were discussed and the effect of alloying elements is indicated. Research to explain the processes observed is discussed. Investigations on hydrogen uptake during corrosion and possibilities of modifying it are described. (tr-auth)

1883 A STUDY OF THE OXIDATION MECHANISM OF Zr–Te ALLOYS USING RADIOTELLURIUM. Mungyu Kang and Shosuke Imoto (Osaka Univ.). Nippon Kinzoku Gakkaishi, 26: 267-70(Apr. 1962).

The oxidation phenomena of Zr–Te alloys were studied by adding small amounts (0.1 to 0.3%) of $Te^{127m}-Te^{127}$ with a specific activity of ~5 mc/g to pure reactor grade Zr sheets by diffusion at 950°C. The alloy samples were either oxidized in air or heated in vacuo at 750°C for 30 hr, and their activities were measured with G-M counters. The Zr oxidized by the oxidation method contained almost the same quantity of Te as the Zr alloy. By separate counting of internal conversion electrons from the Te^{127m} and β rays from the Te^{127} using a 13.6 mg/cm^2 Al absorber, it was observed that the surface concentration of Te was raised markedly by annealing in vacuo, but not by oxidation in air. The Te was far less movable in the oxide than in the Zr alloy, suggesting that Te ions were trapped by oxygen ion vacancies in the ZrO_2. At the same time, the trapping action decreased the mobility of the oxygen ion vacancies. The good oxidation resistance of Zr–Te alloy is explained by this mechanism. (OID)

1884 CORROSION TESTING AND FUEL SELECTION FOR LAMPRE I. C. C. Burwell, R. M. Bidwell, R. P. Hammond, J. E. Kemme, and B. J. Thamer (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 14: 123-34(Oct. 1962). (TID-14496)

The first molten plutonium reactor experiment (LAMPRE I) uses a liquid fuel alloy of plutonium and iron contained in small test tube shaped capsules of tantalum and cooled by liquid sodium. The development of compatible materials for the fuel, container, and coolant has been an important phase of the experiment. The methods of corrosion testing developed for the work and the results of experiments on the composition of the fuel are reported. Both mass transfer attack and intergranular corrosion were found to be significant. Mass transfer was found to be controllable through the use of fuel additives which presumably formed protective layers on the tantalum. Intergranular corrosion was found to be strongly influenced by fuel composition and by container properties. All levels of calcium and magnesium in the fuel were found to be detrimental. Additives which were effective in minimizing mass transfer were found to be not always effective against intergranular attack. Testing methods included tracer techniques, radioautography, chemical analysis, and bend testing. (auth)

1885 THE INFLUENCE OF IONIZING RADIATION ON THE ANTICORROSIVE EFFECT OF DIBENZENE SULFOXIDE IN ORGANIC COATINGS. Zdzistaw Hippe and Waclaw Mauberg (Inst. of Paints and Lacquers, Gliwice, Poland). Przemysl Chem., 41: 198-9(Apr. 1962). (In Polish)

The anticorrosive effect of dibenzene sulfoxide and some of its complex compounds was studied. The inhibitor was solved in the organic phase consisting of a polymer coating on a steel substratum. Corrosive processes, occurring in aqueous solution of radioactive and non-radioactive ruthenium chloride, were examined. The influence of the ionization radiation on the inhibition effect was established. (auth)

1886 PROCESS FOR THE RECOVERY OF THE HEAT OF A NUCLEAR REACTOR. Roger Caillat and Raymond Darras (to Commissariat à l'Énergie Atomique). Canadian Patent 642,736. June 12, 1962.

Oxidation of Mg sheaths of reactor fuel elements by humid air at temperatures up to 500°C may be inhibited by adding a fluorine-containing compound to the air. The concentration of the fluorine compound should be 2 to 10×10^{-4} g/l. After treatment with air containing the compound, the Mg sheaths may be used in air not containing fluorine for several hundred hours. Test data on the corrosion of Mg by air with and without HF are given. (D.L.C.)

Fabrication

1887 (AD-273746) DESIGN DATA STUDY FOR COATED COLUMBIUM ALLOYS. Bimonthly Report No. 1, December 21, 1961 through February 21, 1962. J. D. Gadd (Tapco. Div. of Thompson Ramo Wooldridge Inc., Cleveland). Mar. 21, 1962. Contract NOw 62-0098-c. 23p. (TM-3362-67)

Progress is reported on preparations for the prelimi-

nary screening evaluation of 7 current Nb coatings applied to 30 mil Nb–5Zr alloy sheet. Sheet material for the preliminary evaluation was obtained, test parameters were established and specimens were submitted to various organizations for coating. The preliminary screening tests established involve the determination of oxidation protective life and bend transition temperatures for each of the 7 coating-base metal systems in the as-coated, as-exposed (2000 and 2600°F) and prestrained (room temperature) and exposed (2000 and 2600°F) condition. Baseline data for the 30 mil Nb–5Zr alloy sheet were experimentally established. Brittle to ductile bend transition temperatures were determined for the uncoated sheet in the as-received, stress-relieved and heat-treated conditions and after exposure in air at 2000 and 2600°F for various short time periods. Surface recession and internal penetration oxidation measurements were made on the uncoated sheet. A brief discussion is presented of the design data tests proposed and specialized equipment being constructed. (auth)

1888 (ASC-TR-7-786(I)) INFAB PROCESSING OF TZM SHEET. Phase I. Interim Technical Engineering Report No. 1, April 17, 1962–May 17, 1962. W. A. McNeish (Universal-Cyclops Steel Corp., Bridgeville, Penna.). May 1962. Contract AF 33(657)-8495. 29p. (AD-276268)

A literature survey supported the selection of TZM alloy for this program as the best commercial Mo–base alloy. Vacuum arc, single melted ingots are recommended. The benefits of hot forging both as-cast and extruded billets are reviewed. Both practices are recommended for initial evaluation. Advantages of conducting all elevated temperature fabrication in an inert atmosphere are discussed. A preliminary program outline and schedule of the complete outline is included. (auth)

1889 (ASD-TDR-62-506) COMPARISON OF HIGH ENERGY RATE (DYNAPAK) AND CONVENTIONAL EXTRUSION OF REFRACTORY METALS. Dirk G. Rabenold (Westinghouse Electric Corp. Materials Mfg. Div., Blairsville, Penna.). June 1962. Contract AF33(616)-7842. 90p.

A comparison was made of the surface quality, dimensions, chemistry, hardness, tensile properties, and recrystallization behavior of extrusions produced by high-velocity and conventional techniques. Temperatures were established for the development of hot-worked, cold-worked, and duplex metallurgical structures for the Mo-25W-0.1Zr and W-0.6Nb alloys which were then extruded by both methods at a constant 4:1 reduction ratio. The data indicate that equally good surface conditions can be obtained from the two processes if proper lubrication and tooling are used; lower hot working temperatures can be used for high-velocity extrusions; and lower recrystallization temperatures are obtained in material cold worked on a high-velocity machine. The latter fact indicates that high-velocity-extruded metals retain a higher degree of internal stress than do conventional-extruded metals. (auth)

1890 (BRB-54) DYNAPAK FORMING OF THIN WALLED NATURAL URANIUM TUBING. L. Lewis (Bridgeport Brass Co., Conn.). Feb. 22, 1960. Contract AT(30-1)-1405. 29p. (HAVENS-141)

An experiment to determine the feasibility of utilizing the high-energy-rate potential of the Dynapak to extrude a thin-walled U tubing which has characteristics required by reactors is described. Results indicate that the method warrants further development. (J.R.D.)

1891 (BRB-58) DYNAPAK EXTRUSION OF THIN AND THICK WALLED NATURAL URANIUM TUBING. L. Lewis (Bridgeport Brass Co., Conn.). Oct. 26, 1960. Contract AT(30-1)-1405. 57p.

An experiment to develop the Dynapak extrusion of I&E and thin-walled U tubing is described. Data and discussion concerning metal flow, structure, surface quality, hardness, dimensional aspects, stability and yield are included. Results further substantiate the feasibility of the process. (J.R.D.)

1892 (BRB-61) DYNAPAK EXTRUSION OF 'O' SIZE I + E CORES. P. W. Miller and L. Lewis (Bridgeport Brass Co., Conn.). July 3, 1961. Contract AT(30-1)-1405. 33p.

An experiment was conducted to evaluate the capabilities of DYNAPAK in the extrusion of 'O' size I = E cores. Results indicate that the process has a good potential. Surface quality and dimensional control of the tubing were of high standard. Grain structure and irradiation stability appear to be of a desirable quality. (J.R.D.)

1893 (HW-69200(Pt.I)) PLUTONIUM SPIKE FUEL ELEMENTS FOR THE PRTR. PART I. THE MARK I-G. M. D. Freshley (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 1961. Contract AT(45-1)-1350. 66p.

The fabrication of the first aluminum–plutonium spike enrichment fuel elements for the Plutonium Recycle Test Reactor (PRTR) at Hanford is described. These elements are 8-foot long, 19-rod cluster bundles of 1/2-inch diameter Al–1.8 wt.% Pu–1.35 wt.% Ni–1.10 wt.% Si alloy fuel cores clad in 0.030-in.-thick Zircaloy-2. The discussion includes some of the development activities that were conducted which resulted in the final fuel design and fabrication process. An experimental irradiation testing program was conducted which determined the adequacy of the fuel concept. Operation of the elements in the PRTR will constitute the final fuel evaluation. (auth)

1894 (HW-SA-2680) PLUTONIUM FUEL EXPERIENCE AT HANFORD. I. D. Thomas (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 6, 1962. Contract AT(45-1)-1350. 23p.

A review of research and development on Pu from initiation of the Pu recycle program to the present is presented. Included are discussions concerning Al and Zircaloy cladding, processes for Al–Pu alloys, UO_2–PUO_2 compacting, and pelleting processes. Other information is included on Pu fuel element irradiations. (J.R.D.)

1895 (HW-SA-2757) HIGH ENERGY IMPACT FORMING OF CERAMIC FUELS. D. W. Brite (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [Oct. 4, 1962]. Contract AT(45-1)-1350. 21p.

High-energy impaction was studied as a technique for densifying ceramic powders, such as UO_2, UC, UN, ThO_2, and various other materials. Powders were heated in metal containers and subjected to high-energy-rate impact in a Dynapak machine. Impact pressures up to 200,000 psi were reproducibly achieved with tool steel dies. Cobalt-bonded tungsten carbide dies were usable to 400,000 psi. A modification of the "Bridgman Anvil" technique permitted impaction at 500,000 psi. Uranium dioxide powder was converted to an ultra-high-density (>10.86 g/cc, or 99% TD) bulk nuclear fuel suitable for swaging or vibrational compaction. Two techniques were developed; direct high-energy impaction at 1100°C and 500,000 psi, and high-energy impaction at 1100°C and 200,000 psi to approximately 96% TD, followed by sintering in hydrogen at 1700°C to a final density greater than 99% TD. (auth)

1896 (HW-SA-2783) QUALITY CONTROL IN REACTOR FUEL ELEMENT MANUFACTURING. D. E.

Munro (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 5, 1962. Contract AT(45-1)-1350. 12p.

The manner in which quality-control techniques are applied to the manufacture of reactor fuel elements is discussed. The five characteristics of a metallic uranium fuel element to be controlled are satisfactory nuclear reactivity, sound cladding, satisfactory metallurgical structure, corrosion resistance to the environment, and a cladding material with satisfactory heat-transfer characteristics for the particular situation. Examples of work in quality control are given. (M.C.G.)

1897 (NP-12144) INVESTIGATION OF THE PHYSICAL METALLURGY OF JOINING TUNGSTEN AND COLUMBIUM. Quarterly Progress Report No. 6, May 1, 1962–August 1, 1962. W. R. Young and J. W. Clark (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Aug. 31, 1962. Contract AF33(616)-7484. 66p. (DM62-217; 62AS-12)

The metallographic analysis of 14 braze alloys for Nb was completed. Studies of the effect of brazing parameters and testing variables on joint re-melt temperature were continued. The braze alloys for W were evaluated for melting range and examined metallographically. Electron-beam-melted ingots of W–Hf and W–Hf–C systems were successfully worked into sheet. No evidence of significant grain-boundary hardening in W alloys was observed in transverses made with symmetrical randomly oriented indenters. Annealing of unalloyed W in an ultra-high vacuum environment improved the low-temperature ductility. The tensile shear strength of lap joints diffusion bonded between Nb–Zr and stainless steel, Nb–Zr and Cu, and Cu and stainless steel was determined. (M.C.G.)

1898 (ORO-579) SYNTHESIS AND FABRICATION OF REFRACTORY URANIUM COMPOUNDS. Summary Report, January 1, 1961–March 15, 1962. K. M. Taylor and C. H. McMurtry (Carborundum Co. Research and Development Div., Niagara Falls, N. Y.). May 1962. Contract AT(40-1)-2558. 48p.

It was concluded that the completeness of the reaction of UO_2 and carbon to form UC in vacuum furnacing probably depends upon the activity of the specific UO_2 and carbon, the intimacy of mixing, and the size of pellets heated, as well as time and temperature of heating. Under the conditions of the experiments, there appeared to be no advantage in heating to temperatures higher than 1600°C for periods longer than 75 minutes. The product obtained by synthesizing at higher temperatures for longer periods was no purer and was somewhat less sinterable. With the specific UC prepared by synthesis in vacuum at 1600°C the optimum conditions for sintering in vacuum appeared to be heating at 1940°C for about 80 minutes. Equivalent results were obtained by sintering at atmospheric pressure in flowing helium for 4 hours at 1800°C. Average densities were about 90% theoretical. The additives UC_2 (5%), UO_2 (5%), and UN (10%) had but little effect on the bulk density of UC when sintered in vacuum or in helium under the above conditions. The following additives, in powder form, promoted densification of the UC powder used in this investigation: uranium, iron, and nickel. Uranium metal is effective only if the sintering is done under conditions which prohibit its carbonization or oxidation, both of which take place quite readily. Iron is less effective than nickel and appears to promote more rapid grain growth. Nickel was also superior to uranium metal as a densification aid. About 0.1 to 0.2% nickel appeared to be an optimum amount, with an optimum temperature of about 1525°C when sintering in helium at atmospheric pressure. The presence of appreciable amounts of iron, uranium metal, and free carbon decreased somewhat the effectiveness of nickel. However, the presence of UO_2, UC_2, or UN did not affect the efficiency of nickel, and densities in excess of 95% theoretical were obtained even though these impurities were present in amounts of 5 to 10%. Nickel, in amounts of 0.1 to 0.2%, appeared to promote the formation of U_2C_3 when UC powders were sintered at 1525°C. Metallographic examination indicated that specimens sintered under the above conditions usually contained at least 15% of a second phase believed to be U_2C_3. Chemical analysis indicated that an accurate control of impurity content of specimens prepared for irradiation was not achieved. (auth)

1899 (UCRL-6431) DEVELOPMENT OF DIFFUSION-TYPE BONDING TECHNIQUES FOR BERYLCO-25 ALLOY. G. R. Baxter, J. A. Hoffman, R. C. Bertossa, and B. R. Cottrell (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 8, 1961. Contract W-7405-eng-48. 72p.

Bond tensile strengths in excess of 90,000 psi in joining precipitation-hardened beryllium–copper have been obtained by diffusion techniques. Ordinary brazing techniques for beryllium–copper have resulted in an average of 40,000-psi tensile strength in the bond. Bonds with tensile strengths averaging 108,400 psi have been developed using high-vacuum, diffusion-type bonding techniques. Hardnesses averaging 38 Rockwell "C" can be obtained by air-blast cooling of the beryllium-copper after solution heat treatment (followed by precipitation hardening). (R.J.S.)

1900 (EURAEC-331) STUDY OF THE RESIDUAL WELDING STRESSES PRODUCED BY THE VERTICAL UPRISING WELDING PROCESS. Quarterly Report No. 1, December 15, 1961 to March 31, 1962. (ARCOS. S.A., Brussels). Work performed under United States–Euratom Joint Research and Development Program. Includes Appendices. 81p. A translation.

Activities in a development program on electroslag and electrogas automatic welding processes are reported. Research on determination of residual stresses in single-pass welding deposits and the effects of thicknesses between 15 and 100 mm is emphasized. Work during the report period was devoted to procurement and calibration of measuring equipment and procurement of steel and filler metals for testing. A tabular presentation is included concerning the research plan. The study consists of examining assemblies of increasing thicknesses. Initial examination is in progress on specimens which are 30-mm thick. Methods for the determination of residual stresses are discussed. (J.R.D.)

1901 (EURAEC-375) NON-DESTRUCTIVE WELDING RESEARCH. Quarterly Report No. 4, April 1–June 30, 1962. (Röntgen Technische Dienst N. V., Rotterdam). July 17, 1962. Work performed under United States–Euratom Joint Research and Development Program. Contract 045-61-5RDH. 45p. A translation.

A 2-Mev Van de Graaff generator was used to obtain more than 70 x-ray photographs of a test-block as described previously. In this process, various types of film (coarse-, medium-, and fine-grained) were simultaneously exposed for comparison, and double exposures were made to study the effects of the film treatment. The photographs were made for material thicknesses of 120, 130, 150, 160, 200, 210, 250, and 300 mm with focal lengths ranging from 80 to 150 cm. The exposure times were limited to 1 hour. For this purpose, it was necessary to use a medium-fine-grain film for thicknesses above 210 mm and a coarse-

grain film for thicknesses above 250 mm. The picture quality for 300 mm is such that a groove with a depth of 0.3% of the total thickness is observed at the limit of resolution. When measured by the picture-quality indicators attached to the block, however, the degree of perceptibility is 1%. In the case of thicknesses of 120, 160, 210, and 250 mm, the corresponding degrees of perceptibility are found to be 1.1, 0.9, 0.9, and 0.8%, respectively. If defects are induced at various points in the test-block, or if the focal length is changed, these are represented in the photograph almost exclusively by distortion. The resultant geometrical unsharpness is slight in relation to the internal unsharpness. Measurements to determine the ratio of the image-forming radiation to the stray radiation in the case of an exposure to Co^{60} were initiated. The 50- and 100-mm test plates are being ultrasonically treated for the inducement of defects in the weld. (auth)

1902 (EURAEC-397) ELECTRO-SLAG WELDING OF REACTOR STEELS. Quarterly Report No. 4, April 1, 1962–June 30, 1962. (Schweisstechnische Lehr- und Versuchanstalt, Duisburg, Germany). July 18, 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract 046-61-3-RDA. 67p. A translation.

A compilation and analysis of previously obtained test data are presented tabularly. Included are data and information on welding tests, materials, and additives. Tensile test results are also included along with observations concerning microstructure. It was found that the alloying of Al or Al + Ni in well-defined ratio has favorable effects on the weld microstructure and on the strength of weld alloys. Other findings include improvements instituted by the use of various additives and by composition changes. Plans for future developmental work are included. (J.R.D.)

1903 THE STATUS OF BERYLLIUM METAL IN NUCLEAR REACTORS. PART II. P. Loewenstein (Nuclear Metals, Inc., Concord, Mass.). Atompraxis, 8: 357-62 (Sept. 1962). (In English)

The use of beryllium in nuclear power reactors is extremely attractive from an economic point of view. Almost all types of reactors now under consideration could use beryllium metal to advantage. The principal reasons why beryllium is not used more widely are the high cost of the material, the physical properties, the irradiation properties, and to some extent the toxic properties. All of these negative aspects of the metal are under active investigation, and the entire beryllium picture is in a state of flux. It is likely that many or all of the objectionable features will be reduced or eliminated. Solutions to the problems will be forthcoming within a matter of a few years, and the use of beryllium in reactors should increase considerably. (auth)

1904 FACTORS AFFECTING BRAZED JOINT STRENGTH IN HIGH TEMPERATURE APPLICATIONS. Forbes Miller (Wall Colmonoy Corp., Detroit). Brit. Welding J., 9: 554-8(Oct. 1962).

Designers usually request joint strength figures for various brazing filler metals. These cannot be supplied, as other factors in a brazed assembly are more important to the strength of the brazement than the filler metal choice. The base-metal has far more influence on joint strength. Filler metals should be assessed for ability to resist corrosion and oxidation, re-melt temperatures, readiness to diffuse, flow characteristics, etc. Brazing procedures and joint designs are also important factors in achieving strong brazed joints. (auth)

1905 APPARATUS FOR FORMING SMALL CERAMIC SPHERES. Paul F. Stablein (Argonne National Lab., Ill.). J. Am. Ceram. Soc., 45: 505-6(Oct. 1962). (ANL-FGF-248)

A device for producing a small sphere from a ceramic body of any shape is described in which jets of air blow the body around an abrasive cavity. The device comprises a short section of a furnace tube between end plates, and six jet holes are located in one end plate. The device was used successfully on UO_2, ThO_2, Al_2O_3, etc. Ten to 30 minutes is required to produce a UO_2 sphere. (D.L.C.)

1906 MANUFACTURE OF CRACK-FREE, SMALL ZIRCALOY TUBING BY DRAWING ON A DUCTILE, DISPOSABLE CORE. N. H. Polakowski (Argonne National Lab., Ill.). J. Inst. Metals, 91: 44-7(Oct. 1962).

Fabrication of Zircaloy-2 tubing by Rockrite rolling and/or drawing is often impeded by more or less severe radial cracks which usually start at the inside surface and propagate into the wall. An analysis of conventional manufacturing procedures indicated that wrinkling and cracking were associated with extensive circumferential compression of the unsupported internal surface during sinking operations. A process was developed whereby sound tubing as small as 0.080 in. outside dia × 0.050 in.-inside dia can be produced by drawing the extruded shell on a closely fitting, ductile metal core (copper, 70:30 brass, &c.) which co-extends with the Zircaloy. Reductions of 60, 70, or even 90%, and lower than usual inter-stage annealing temperatures, (500 to 600°C in air) cause no ill effects and the core can be freely removed after being plastically stretched following final annealing. Other hard-to-draw metals (titanium, niobium) can also be processed in this manner. (auth)

1907 FABRICATION OF TANTALUM FUEL CONTAINERS FOR THE LAMPRE I MOLTEN PLUTONIUM REACTOR. G. S. Hanks, R. S. Kirby, and J. M. Taub (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 14: 135-43(Oct. 1962).

An impact extrusion procedure was developed to fabricate a tantalum container approximately 9 in. long, 0.375 in. ID, 20 to 30 mils in wall thickness, and closed at one end. A solid slug was given five impact steps to form a thick-walled cup. The cup was ironed through six stages to the final shape. The material used initially was powder metallurgy tantalum; high purity, electron-beam melted tantalum and tantalum containing 0.1 wt % tungsten was used in later work. Aluminum bronze dies and a cold beeswax lubricant were used to prevent galling between the tools and the tantalum. Thirty to forty tons were required to form the metal in the impact extrusion steps. Draw force needed in the ironing operation ranged from 600 to 3600 lb. The Ta + 0.1 wt % tungsten alloy consistently required greater impact extrusion and draw pressures than were required by the high purity metal. The investigation showed that heat treating procedures had a considerable effect on the surface finish by controlling the grain size in the metal. In general, tantalum was found to form satisfactorily in both the impact extrusion and ironing procedures. (auth)

1908 PROPERTIES OF FRICTION WELDS BETWEEN DISSIMILAR METALS. Thomas H. Hazlett (Univ. of California, Berkeley). Welding J., (N. Y.), 41: 448s-50s(Oct. 1962).

An investigation was conducted on the friction welding of Zr, 304 stainless steel, 2024 Al alloy, Mg, Ni, and Cu to themselves and of four dissimilar metal combinations. A wide range of weld and forge forces was used with a constant speed, 3200 rpm. The welds of metals to themselves were satisfactory except with Cu. The dissimilar metal combinations are welded together in the following order of increasing difficulty: 2024 Al alloy to Cu, Zr to mild steel, Zr to 304 stainless steel, and Ni to Mg. Some of the factors influencing weldability are believed to be hot strength, coefficient of friction, and axial alignment. (D.L.C.)

1909 FABRICATION OF FUEL ELEMENTS. G. Matz (Nuclear-Chemie und Metallurgie G.m.b.H., Wolfgang bei, Hanau am Main, Germany). Review Series No. 25 of "Developments in the Peaceful Applications of Nuclear Energy" of the International Atomic Energy Agency, Vienna. Sept. 1962. (STI/PUB/15/25). $1.00(IAEA).

The production of fuel elements is briefly surveyed. Their development is now so far advanced that the methods of production are standardized. This survey is accordingly limited to such fuel elements as are now manufactured on a large scale, viz., elements with U metal and UO_2 dispersion elements with a UAl alloy or U_3O_8-Al-Cermet as fuel and, lastly those with a carbide fuel, either pure UC for organic cooled and liquid-metal cooled reactors, or a UC_2-C mixture for He-cooled high-temperature reactors such as Dragon and Pebble Bed. In connection with the organic elements, brief reference is made to cold compacting processes (swaging, vibratory compacting) which, to an increasing extent, are coming to use side by side with standard sintering processes. As there is as yet no standard technology for Pu fuels, a representative example is quoted, i. e. the method proposed for producing the fuel elements for the EBR-II reactor in the United States. An attempt is made to explain the reasons for choosing a given kind of fuel (metal, oxide, carbide) or form of fuel (rods, rod assembly, tubes, plates). The main characteristics of the fuel are explained if necessary for an understanding of the individual steps in manufacture (e. g. the anisotropism of alpha U to explain the need for heat treatment). Reference is made to the most important can materials, and certain characteristic aspects of fuel element production such as the canning, bonding, and welding of the can are explained. (auth)

1910 MANUFACTURE OF BERYLLIUM TUBES. William Arthur Sallis and Joseph Clifford Guest (to T. I. (Group Services) Ltd.). British Patent 907,360. Oct. 3, 1961.

British Patent 884,410 describes a method for manufacturing Be tubes, in which a hollow Be billet is made and surrounded by an extensible core and envelope, the assembly is heated to 900 to 1100°C and extended to the desired diameter, and the core and envelope are then removed by pickling. The present invention is an improved method whereby the amount of pickling and the tensile stresses in the Be are reduced. In this method, the Be billet is covered successively by a tubular liner and an outer casing formed of several parts detachable from the liner. The liner thickness is chosen so that it can be pickled away from the Be in approximately the same time as that required to pickle away the core. The components of the assembly are coated with lime before extrusion to prevent welding together. (D.L.C.)

1911 METHODS OF PRODUCING CANNED FUEL ELEMENTS FOR NUCLEAR REACTORS. Aage Christian Winter and Ole Erikson (to Atomenergikommissionen). British Patent 908,857. Oct. 24, 1962.

A method is outlined for producing canned reactor fuel elements with a molten heat-transfer metal between the can and fuel sections. The method comprises loading the fuel sections with interposed solid discs of the heat-transfer metal into the can and heating the can from bottom to top to melt the discs. In order to assure that the air escapes from the can during the melting, the can is vibrated, a reduced pressure is maintained in the can, and/or a compression device is introduced in the upper end of the can. (D.L.C.)

1912 IMPROVEMENTS IN OR RELATING TO THE PREPARATION OF URANIUM SILICIDE ARTICLES. (to Commissariat à l'Énergie Atomique). British Patent 908,941. Oct. 24, 1962.

A process is given for preparing non-porous shaped articles of U_3Si_2, USi, USi_2, and USi_3. The process comprises introducing into a mold an intimate mixture of U and Si particles in the desired proportions, heating the mixture under vacuum to at least 450°C (say 625 to 675°C) to solidify the mixture, and completing the U–Si reaction by removing the mixture from the mold and heating with induction to 1400 to 1500°C in vacuum. Apparatuses for making cylindrical bars with this process are described. (D.L.C.)

1913 METHOD OF BRAZING GRAPHITE ARTICLES. (to Nihon Genshiryoku Kenkyusho). British Patent 909,049. Oct. 24, 1962.

A method is given for forming firm and leak-tight joints between graphite articles for use in reactors. The method uses a brazing alloy containing more than 40.8% Fe and one or more of Cr, Ni, Mo, W, Ti, Zr, and C, and the brazing may be done by induction heating at 1200 to 1600°C or arc heating. The resulting bonds are strong and corrosion-resistant and have only a small effect on the neutron economy of a reactor amounting to an increase of 10% in the neutron absorption cross section when the amount of alloy used is $\frac{1}{3000}$ of the graphite mass. (D.L.C.)

1914 IMPROVEMENTS RELATING TO BITUMINOUS MIXTURES. William Albert Mount (to Associated Electrical Industries Ltd.). British Patent 909,072. Oct. 24, 1962.

A method is outlined for forming non-settling mixtures of bitumen and a heavy material such as a boron compound or lead for radiation shielding applications. The method comprises first adding a clay to the bitumen to form a gel with the oil components thereof, and then adding particles of a heavy material. Preferably, the clay is a modified clay with the trademark Bentone or Fulbent, while the bitumen may be Tarene or Mexphalt, and the mixture proportions are typically bitumen 92 to 70%, clay 5 to 15%, and heavy material 3 to 15%. (D.L.C.)

Properties and Structure

1915 (AD-274206) INVESTIGATION OF MOLYBDENUM- AND TUNGSTEN-BASE ALLOY SHEET MATERIALS. Third Quarterly Report, November 25, 1961 to February 24, 1962. Gordon D. McArdle, Robert Q. Barr, and M. Semchyshen (Climax Molybdenum Co. of Michigan, Detroit). Contract NOw 61-0581-d. 11p.

Room temperature tensile tests and bend transition temperature determinations were conducted on stress-relieved and recrystallized specimens of several high strength Mo-base and W-base alloy rolled sheets. The 50-mil-thick sheet stock was rolled in air on a conventional sheet rolling mill. The preparation and rolling of additional sheet bars of the same alloys in the InFab facility is also described. (auth)

1916 (ARF-2215-6) SEAL AND INSULATOR PROBLEMS IN THERMIONIC CONVERTERS. Summary Report, February 15, 1961–February 15, 1962. David W. Levinson (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Mar. 12, 1962. Contract NONR-3441(00). 88p. (AD-273481)

A discussion of the materials requirements for seals and insulators for thermionic energy converters is presented. Based on the requirements and published physical property data, Al_2O_3 appeared to be the most desirable insulator material at temperatures below its melting point.

The study includes a discussion of metal ceramic sealing technology and a bibliography of publications in the field covering 1959, 1960, and part of 1961. (auth)

1917 (ARL-62-427(Pt.II)) ON THE COMPOSITION, STRUCTURE AND MAGNETIC PROPERTIES OF SOME URANIUM CHALCOGENIDES. F. Groenvold, H. Haraldsen, T. Thurmann-Moe, and T. Tufte (Oslo. Universitetet). Mar. 31, 1962. Contract AF61(052)-178. 68p.

Uranium sulfides in the range $US_{1.5}$ to $US_{2.1}$ were prepared from high purity elements at temperatures up to 1400°C. The most uranium-rich phase obtained in pure state was the previously described U_3S_5. It has an orthorhombic structure with lattice constants: a = 7.411 Å, b = 8.100 Å, and c = 11.747 Å. The unit cell is primitive and probably contains 12 uranium and 20 sulfur atoms. The reported polymorphism of US_2 was not confirmed. The US_2-phase was found to have a rather broad homogeneity range between about $US_{1.80}$ and $US_{1.95}$. At these two compositions the lattice constants of the tetragonal structure are a = 10.301 Å, c = 6.363 Å and a = 10.259 Å, c = 6.342 Å, respectively. The highest symmetric space group is $P4/nmm-D_{4h}^7$, and the unit cell contains about 11 uranium and 20 sulfur atoms. At the stoichiometric composition US_2 only the orthorhombic structure of US_2 was observed, even after quenching from 1400°C or heat treatment for one month at 400 to 410°C. Its composition range is narrow and the redetermined lattice constants of $US_{2.0}$ are: a = 4.124 Å, b = 7.117 Å, and c = 8.479 Å. A two-phase region was observed from $US_{2.1}$ to $US_{2.9}$ with US_3 as the most sulfur-rich phase. The lattice constants of its monoclinic structure are: a = 5.37 Å, b = 3.96 Å, c = 9.06 Å, and β = 97.2° for $US_{3.0}$. The highest symmetric space group is $P2_1/m-C_{2h}^2$, and the unit cell contains 2 uranium and 6 sulfur atoms. The most uranium-rich selenide prepared by heating the elements to 1000°C was the U_3Se_5-phase. In agreement with earlier results its structure is of the same type as U_3S_5. For $USe_{1.7}$ the lattice constants are: a = 7.760 Å, b = 8.442 Å, and c = 12.260 Å. The phase had a noticeable range of homogeneity. At higher selenium contents the $USe_{1.9}$-phase, isotopic with $US_{1.9}$ and with variable composition was encountered. Its lattice constants are: a = 10.772 Å and c = 6.668 Å for $USe_{1.8}$, and a = 10.698 Å and c = 6.610 Å for $USe_{2.0}$. The earlier reported USe_2 β- and USe_2 γ- phases were not observed. The only phase richer in selenium than $USe_{1.9}$ found in this study was the USe_3-phase. Its lattice constants were found to be: a = 5.65 Å, b = 4.06 Å, c = 9.55 Å, and β = 97.5°. Preliminary studies of the uranium tellurides confirmed the presence of a phase with cubic face-centered structure and composition in the range UTe to $UTe_{1.33}$, a = 9.422 and a = 9.390 Å, respectively. Furthermore, a tritelluride was observed with monoclinic structure and lattice constants: a = 6.10 Å, b = 4.22 Å, c = 10.34 Å, and β = 97.8°. Magnetic measurements of the sulfides $US_{1.6}$, $US_{1.9}$, US_2, and US_3, and the selenides USe_2 and USe_3 were carried out by the Gouy method at temperatures from −183 to 445°C. The Curie law was obeyed for $US_{1.6}$ with a resulting magnetic moment of 3.01 μB, while for $US_{1.9}$ and US_2 the Curie-Weiss law was followed with Δ of about −50 and −30°, respectively. The magnetic moment of $US_{1.9}$ is thus 3.07 μB, and that of US_3 is 3.14 μB. For US_3 the Curie-Weiss law is obeyed only above room temperature with $\Delta = -100°$, which leads to the same magnetic moment as for US_2. The susceptibility of $USe_{2.0}$ follows the Curie-Weiss law with $\Delta = -40°$. The values for USe_3 are almost coinciding above room temperature. The magnetic moments are 3.05 μB, which indicate the presence of two unpaired 5f electrons, just as for the sulfides. (auth)

1918 (ASD-TDR-62-432) INVESTIGATION OF DIFFUSION BARRIERS FOR REFRACTORY METALS. E. M. Passmore, J. E. Boyd, and B. S. Lement (ManLabs, Inc., Cambridge, Mass.). May 1962. Contract AF33(616)-6354. 95p.

Thirty-three base barrier combinations involving the four refractory metals W, Mo, Ta, and Nb and 12 potential barrier metals having melting points over 1700°C were evaluated for relative interdiffusion behavior at 1700 and 1800°C. The relative extent of interdiffusion decreased with increasing base-barrier solidus temperature, although wide variations occurred for melting points up to 2100°C. Interdiffusion in the Mo−Cr combination was found to be substantially reduced by the presence of a Re barrier. Re, Ru, and Ir barriers appeared optimum for W base metal; W, Re, Ru, and Ir appeared optimum for Ta; and W, Re, Os, and Zr appeared optimum for Nb. The thickness (X) of the total interdiffusion zone as well as of the intermediate phase layers in the W−Re, Mo−Re, Ta−Re, and Nb−Re combinations was found to increase with time (t) in accordance with the relationship $X^n = kt$, with values of n in the range 1.4 to 4.9. (auth)

1919 (ASRL-TR-94-4) MECHANICAL BEHAVIOR OF THE TWO-PHASE COMPOSITE, TUNGSTEN−NICKEL−IRON. Richard H. Krock and Lawrence A. Shepard (Massachusetts Inst. of Tech., Cambridge. Aero-Elastic and Structures Research Lab. and Massachusetts Inst. of Tech., Cambridge). Aug. 1962. Contract AF49(638)-775. 38p.

A series of ductile, two phase W−Ni−Fe composites, sintered in the presence of a liquid phase, was tested in tension. Identical room-temperature stress-strain curves were obtained for specimens containing from 80 to 92 wt. % W (58 to 75 vol. % W particles). The composites exhibited a maximum elongation of 29% at room temperature, and 10.7% at 77°K. The W particles in the composite elongated by the same amount at these temperatures. Single phase alloy specimens matching the composition of the composite matrix showed about one half the flow stress of the composites. The test results demonstrated that the mechanical properties of W-Ni-Fe composites are determined by the W particles alone and are independent of matrix volume fraction or mean free path over the composition range studied. (auth)

1920 (BM-RI-6078) STUDIES OF MAGNESIUM ALLOYS FOR USE AT MODERATE TEMPERATURES. R. L. Crosby and K. A. Fowler (Bureau of Mines. Rolla Metallurgical Research Center, Mo.). Jan. 1962. 31p.

Data from studies of wrought Mg alloys containing rare-earth elements are presented on the mechanical properties of the alloys at room temperature and at 100, 200, and 300°C. Results of studies of the solid solubility of Ce and Zr in Mg, as determined by electrical resistance measurements, are also discussed and are compared with those of other investigators. The strength of Mg−Ce alloys did not increase with the addition of V and TiO_2. The addition of Zr increased the tensile strength of the alloys as much as 10,000 psi at room temperature, but this increase diminished above 100°C. (auth)

1921 (BMI-X-10019) DEVELOPMENT OF URANIUM MONONITRIDE. Quarterly Progress Report, July-September 1962. Donald L. Keller (Battelle Memorial Inst., Columbus, Ohio). Oct. 1, 1962. Work Performed under United States−Euratom Joint Research and Development Program. Contract W-7405-eng-92. 13p. (EURAEC-466)

Progress is reported in the establishment of feasibility

of UN as a reactor fuel. Properties and methods of preparation by arc-melting are set forth. (R.J.S.)

1922 (BNL-6322) THEORY OF POINT DEFECT ANNEALING IN METALS. A. C. Damask and G. J. Dienes (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract [AT(30-2)-Gen-16]. 13p.

The kinetics of the annealing of point defects, either by migration to sinks or by recombination, is complicated by the occurrence of a variety of simultaneous reactions. An extensive theoretical study of annealing processes is in progress based on the isolation and combination of simple kinetic steps. When analytic solutions could not be found, computer solutions were used to obtain useful approximations and to determine their regions of validity. Two migration reaction schemes were studied: the simultaneous annealing of single and di-vacancies and the annealing of single vacancies with impurity trapping. Three recombination reactions were investigated: vacancy-interstitial annihilation with interstitial migration to sinks, di-interstitial formation, and interstitial trapping at impurities. (auth)

1923 (BNL-6338) OXIDATION AND DISLOCATION MECHANISM IN FATIGUE CRACK FORMATION. F. E. Fujita (Brookhaven National Lab., Upton, N. Y.). [nd.]. Contract [AT(30-2)-Gen-16]. 24p.

A discussion concerning the mechanism of extrusion and intrusion formation is presented. A model involving dislocation motions is proposed by which experimental results are explained. In this first stage of fatigue defect formation, it appears that O_2 is not involved. While in the second stage, in which microcracks are formed oxidation is probably important. The effects of oxidation in the third stage, in which cracks of macroscopic size propagate steadily through the area and lead finally to fatigue failure, are most significant. A discussion of each phase is included. (J.R.D.)

1924 (CEA-2104) CONTRIBUTION A L'ETUDE DE LA MICROSTRUCTURE DU BIOXYDE D'URANIUM. (Contribution to the Study of the Microstructure of Uranium Dioxide). Alexandre Porneuf (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). 1962. 112p.

Thesis submitted to Paris. Universite.

The microstructure of sintered uranium dioxide was studied in relation with several parameters. Especially the sintering temperatures and atmospheres. The external surface and the internal microstructure were examined, using fractography and ceramography. Various techniques for preparing surfaces (mechanical and electrolytic polishing) and for revealing the structure (chemical and anodic attack, ionic bombardment oxidation) were used and compared. Patterns similar to those revealed in metals and probably related with interactions between dislocations and vacancies were observed. (auth)

1925 (CEA-2116) CONTRIBUTION A L'ÉTUDE DES LACUNES DANS L'ARGENT ET L'URANIUM. (Contribution to the Study of Vacancies in Silver and Uranium). Yves Quere (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Saclay). 1962. 73p.

Thesis submitted to Paris. Université.

In metals, high-temperature vacancies can be retained by quenching. Results are given for the quenching of uranium (in liquid helium) and of silver (in liquid nitrogen). In this last case the energy of formation (1.06 ev) and the energy of mobility (0.86 ev) of the vacancies were measured as well as the energy of mobility of the divacancies (0.58 ev). If the quenching is slow, it is shown that it is possible to trap the vacancies on the impurities of the metal. This leads to increases in the electrical resistivity observed by annealing after quenching, the vacancies being released before disappearing into sinks. The vacancy-impurity binding energy (the impurity being probably oxygen which is present in the silver used at a concentration of 20 ppm atom) can thus be estimated to be 0.4 ev. (auth)

1926 (D-82-0194) NUCLEAR MAGNETIC RESONANCE IN METAL SINGLE CRYSTALS. Harlan E. Schone (Boeing Scientific Research Labs., Seattle). Aug. 1962. 8p.

The use of nuclear magnetic resonance in studying properties of the solid state is discussed. The basic resonance phenomenon is described. Resonances were observed in single crystals of Cu, Cd, Li, V, and Nb. (M.C.G.)

1927 (DCAS-TR-61-28) THERMODYNAMIC AND TRANSPORT PROPERTIES OF RUBIDIUM VAPOR AND CESIUM VAPOR. Lawrence Baylor Robinson (Aerospace Corp., El Segundo, Calif.). Dec. 19, 1961. Contract AF04(647)-930. 15p. (AD-273594; TDR-930(2220-50) TR-1)

Thermodynamic and transport properties of Rb and Cs vapors were determined from theory, supplemented by experimental results. The situation for which results were obtained involves negligible ionization of the alkali atoms. The model used was imperfect gas obeying the virial equation of state. The second virial coefficient was considered adequate to account for deviations from the ideal behavior in the temperature and pressure range under consideration. It was assumed that the vapors are comprised of alkali atoms whose interactions are the pairwise Lennard-Jones type. On the basis of the 2 parameters which occur in the Lennard-Jones potential for interactions between some alkalis and noble gas atoms and the known parameters for the noble gas atoms, the parameters were estimated for the alkalis. From these parameters the desired thermodynamic and transport properties of Rb and Cs vapors are obtained. Numerical values are given for the important properties. (auth)

1928 (DMIC-Memo-160) IDENTIFICATION OF MICROCONSTITUENTS IN SUPERALLOYS. C. H. Lund and H. J. Wagner (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Nov. 15, 1962. Contract AF 33(616-7747). 30p.

Methods are set forth for the separation and identification of microconstituents in nickel, iron, and cobalt superalloys. (R.J.S.)

1929 (GA-3588) PYROLYTIC-CARBON-COATED CARBIDE FUEL PARTICLES AND THEIR USE IN GRAPHITE-MATRIX FUEL COMPACTS. Walter V. Goeddel, ed. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Oct. 30, 1962. Contract AT(04-3)-314. 84p.

A summary of the development and evaluation of pyrolytic-carbon-coated carbide fuel particles and graphite-matrix fuel compacts is presented. A process that was developed for the preparation of particles of thorium-uranium dicarbide is described. Granulated particles composed of powdered UO_2, ThO_2, and carbon are suspended in a bed of graphite flour and heated to convert the oxides to dicarbides. The particles are then melted to densify and spheroidize them, while the graphite flour keeps them separated so they will not flow together. Coating the (Th, U)C_2 particles with pyrolytic carbon is accomplished in a fluidized-bed apparatus using a methane–helium mixture at a temperature of ~1400°C. Data are presented on the properties of coatings deposited at temperatures to 2400°C. Graphite-matrix fuel compacts of high density are prepared by a hot-pressing process. Graphite flour is used as the filler and pitch as the binder; the use of graphite flour, rather than

coke, permits the attainment of good thermal properties in the compacts without the necessity for high processing temperatures. The hot-pressing process is described and the properties of the compacts are given. The thermal stability of coated fuel particles was evaluated at temperatures to 2000°C and for times up to one year. Some coated particles were found to fail in thermal gradient tests because of the movement of the particle through the coating on the high-temperature side; this was named the "amoeba effect." Tests of coated particles show that there should be no thermal instability at temperatures up to 1500°C for periods of at least three years. Results of extensive irradiation tests of graphite-matrix fuel compacts prepared by the hot-pressing process are presented. The compacts containing uncoated (Th, U)C_2 particles were dimensionally stable after burnups of 6.9×10^{19} fissions/cm^3 at 1100 to 1500°C. Compacts containing coated particles were tested to burnups of 1.2×10^{20} fissions/cm^3 at temperatures as high as 2000°C. A few per cent of the particle coatings were found to be broken after these tests. Possible explanations for these failures are presented. (auth)

1930 (HW-73859(Rev.)) LOCALIZED OXIDATION IN NUCLEAR GRAPHITES. B. A. Ryan (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 14, 1962. Contract AT(45-1)-1350. 19p.

The pits on small samples and the craters on the ends of large bars which develop during the oxidation of nuclear-grade graphite are the result of impurity-catalyzed reactions. This conclusion was drawn from autoradiography of small samples and ashing results from large bars. In some cases impurities were found in relatively large regions. This concentration of impurities probably develops during the graphite manufacturing process, perhaps as a combined result of temperature gradients and the nonuniformity of diffusion of the purifying gases throughout the graphite bars. (auth)

1931 (HW-74339) IMPACT TESTING AND SLOW NOTCH-BEND TESTING OF ZIRCALOY-2. R. L. Call (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 17, 1962. Contract AT(45-1)-1350. 82p.

Sub-size V-notch Charpy impact tests and a notch-bend test were utilized to evaluate some of the effects of specimen orientation, temperature, hydrogen addition, and cold work on Zircaloy-2. At low temperatures the longitudinal-vertical (LV) orientation had a higher impact strength than did the transverse-vertical (TV), transverse-horizontal (TH), and longitudinal-horizontal (LH) orientations. At high temperatures, 300°C (572°F), the transverse-vertical orientation had the highest impact strength. The addition of 100 or 500 ppm hydrogen lowered the impact strength and raised the brittle-to-ductile transition temperature. Cold working the specimens 12.5% also lowered the impact strength at low temperatures and raised the brittle-to-ductile transition temperature. At high temperatures the impact strength of cold-worked specimens was nearly the same as for annealed specimens. Hydrogen addition and cold work had effects on fracture angle and transition temperature in the notch-bend test similar to their effects on impact strength in the impact test. However, the transition temperature was not raised as much in the notch-bend test as in the impact test. Also, the transverse-horizontal orientation in the notch-bend test had a lower fracture angle than did the other three orientations, particularly for the cold-worked specimens, which fractured at a relatively low angle even at 400°C (752°F). An attempt was made to correlate the notch-bend test with the V-notch Charpy impact test but no correlation was found. (auth)

1932 (HW-74802) THE PLUTONIUM–OXYGEN SYSTEM. T. D. Chikalla, C. E. McNeilly, and R. E. Skavdahl (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Sept. 1962. Contract AT(45-1)-1350. 30p.

The crystallographic, thermodynamic, and physical properties of Pu-O compounds with varying oxygen-to-plutonium ratios are presented and discussed relative to the construction of a phase equilibria diagram for this system. Property determinations included melting and dissociation temperatures, thermal expansion, lattice constants, and electrical resistivity. The most unusual feature of the diagram is a two-phase solid immiscibility region at low temperatures for oxygen-to-plutonium ratios between 1.70 and 1.98. Certain portions of the diagram are still uncertain because of the experimental difficulties associated with the ease with which $PuO_{2.00}$ loses oxygen at high temperatures and suboxides gain oxygen. (auth)

1933 (HW-75148) THERMAL EXPANSION OF URANIUM DIOXIDE. J. A. Christensen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 4, 1962. Contract AT(45-1)-1350. 9p.

The density and thermal expansion of uranium dioxide between 1200 and 3100°C were measured by high-temperature radiography of single crystals sealed in tungsten vessels. (auth)

1934 (HW-SA-2755) SYNTHESIS AND PROPERTIES OF PLUTONIUM MONONITRIDE. D. F. Carroll (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 17, 1962. Contract AT (45-1)-1350. 16p.

Preparation of plutonium nitride, PuN, was accomplished by arc-melting alpha plutonium under one atmosphere of nitrogen, by reacting plutonium hydride with anhydrous ammonia at 600°C, and by a two-step process reacting plutonium with hydrogen to form the hydride and converting this to PuN in a nitrogen atmosphere. The arc-melted product consisted of PuN dendrites in a plutonium matrix; metallographic, chemical, and density data indicated an 85 to 95% conversion. Properties measured include density, melting point, hardness, chemical stability, and thermal expansion. Also some data are presented concerning the stability of PuN at its melting point. The purity of PuN used for each of the various property determinations is defined by x-ray-diffraction, chemical, and emission spectrographic analyses. (auth)

1935 (HW-SA-2778) FISSION FRAGMENT AND PLUTONIUM MIGRATION IN URANIUM DIOXIDE FUEL. J. L. Bates, J. A. Christensen, and W. E. Roake (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 15, 1962. Contract AT(45-1)-1350. 13p.

Experiments showed extensive relocation of several fission product elements and plutonium in UO_2 fuel. Thin glass plates in contact with polished UO_2 surfaces darkened in proportion to the density of radioactive nuclei in the adjacent fuel. This produced maps of the UO_2 surfaces showing the variation in gross concentrations of radioactive fission products. More precise fission fragment concentration data were obtained by radiochemical analyses. Gross relocation of fission products in the columnar grain growth regions was observed in all test elements examined. It was found that distributions of Ce^{144}–Pr^{144}, Zr^{95}–Nb^{95}, Ru^{103}–Ru^{106}, and Cs^{137} followed the same pattern. The areas of maximum and minimum were associated with characteristic UO_2 microstructures developed during irradiation. It was determined that Cs^{137} concentration varies by a factor

of more than 20 over a radial distance of approximately 1/8 in. in some of the fuel elements. The plutonium distribution showed relatively minor departure from that calculated from theory. (M.C.G.)

1936 (HW-SA-2782) SOME OBSERVATIONS ON THE PROPERTIES OF THE DEFECT PuC PHASE. J. B. Burnham, Jr. and T. D. Chikalla (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 4, 1962. Contract AT(45-1)-1350. 18p.

In order to study the crystal structure properties of PuC, a series of buttons was made by arc melting high-purity plutonium with spectrographic-grade carbon. Each button was drop cast into 3 rods. Chemical analysis, heat treatments, and x-ray analysis were carried out. Densities were measured. It is shown that the zeta phase does not exist in arc-cast samples above 40 at. % C but does occur below this composition. Densities indicated the presence of a carbon-deficient lattice between 48 and 42 at. % C. The variation of the PuC lattice parameter as a function of carbon content is shown. (M.C.G.)

1937 (HW-SA-2803) CREEP PROPERTIES OF ZIRCALOY FOR DESIGN APPLICATION. P. J. Pankaskie (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 10, 1962. Contract AT(45-1)-1350. 39p.

Long-term (circa 10,000 hours) creep data for constant load and temperature, and temperature and load cyclic conditions, were obtained for Zircaloy-2 in the annealed and 15% cold-worked condition. In the annealed condition, creep behavior is substantially influenced by strain-age-hardening phenomena. In the 15% cold-worked condition, creep behavior is very regular and predictable. (auth)

1938 (IDO-14581) LOW TEMPERATURE POLYMORPHIC TRANSFORMATIONS OF CALCINED ALUMINA. R. F. Murray and D. W. Rhodes (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Sept. 28, 1962. Contract AT(10-1)-205. 28p.

The factors which affect the transformation of amorphous alumina to crystalline alumina in the temperature range 350 to 650°C were studied. Amorphous alumina, with small amounts of added "impurities", was heated in an atmosphere containing the oxides of nitrogen, air, and water vapor, and the amount of crystalline alumina was determined. Alpha alumina was the predominant crystalline form after heating amorphous alumina that was prepared in a fluid bed calciner. The effects of temperature, composition of the atmosphere, time of heating, impurities, and method of preparation of the amorphous alumina on the transformation to crystalline phases were investigated. An atmosphere containing water vapor and the oxides of nitrogen and a small amount of sodium nitrate in the alumina product were necessary to produce the alpha alumina phase from amorphous alumina at the relatively low temperature of 400°C. Boric acid added to the fluid-bed calciner feed successfully inhibited the formation of the alpha crystalline form. (auth)

1939 (LADC-5445) THE MAGNETIC PROPERTIES OF PLUTONIUM HYDRIDE AND DEUTERIDE. C. E. Olsen, T. A. Sandenaw, and B. T. Matthias (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract [W-7405-eng-36]. 6p.

Magnetic investigations of plutonium hydride ($PuH_{2.74}$) and deuteride ($PuD_{2.74}$) showed these compounds to be ferromagnetic, like the corresponding uranium compounds. The Curie temperatures of plutonium hydride and deuteride are the same, within experimental error, and are 107°K. The magnetic moment for the hydride and deuteride are greater than 0.24 and 0.13 bohr magnetons per mole of compound respectively at 76°K. In addition the cubic plutonium oxide $PuO_{1.62}$ was found to be either ferro- or ferrimagnetic with a magnetic moment greater than 0.16 bohr magnetons per mole of plutonium at 4°K and a Curie temperature of 96.7°K. (auth)

1940 (NP-12197) STATIC FATIGUE FRACTURING OF HIGH PRESSURE GAS VESSELS. Frank R. Larson (Watertown Arsenal Labs., Mass.). [1961]. 16p.

The problem of delayed failures is reviewed along with mechanisms of crack propagation and fracture mechanics. Differences in behavior patterns for high toughness and low toughness materials in relation to crack-like flaws and load carrying ability are illustrated. Stress corrosion or hydrogen embrittlement is shown to aid slow crack propagation to the fracture boundary. Recommendations for the elimination of these types of failures are included along with an example of the successful solution of a typical problem. (auth)

1941 (NP-12214) PROGRESS REPORT NO. 31 [ON INSULATION]. (Massachusetts Inst. of Tech., Cambridge. Lab. for Insulation Research). July 1962. Contracts Nonr-1841(10); Nonr-1841(88); AF19(604)-6155; AF33(616)-8353; AF19(604)-8483; AF-AFOSR-62-317. 89p.

Research and development progress on insulation is reported under the following topics: high-dielectric-constant materials; high-temperature dielectrics; breakdown, field emission, and dielectric and elastic spectroscopy; crystal physics; magnetics; mathematical crystallography; magnetic spectroscopy; and optical modulation. (M.C.G.)

1942 (PWAC-375) MECHANISMS OF WORK HARDENING IN BODY CENTERED CUBIC METALS. Donald P. Gregory and George H. Rowe (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). July 12, 1962. Contract AF33(616)-7855. 145p.

To be published as ASD-TDR-62-354.

The work-hardening literature on refractory metals is surveyed, and an analysis of survey findings in the light of current dislocation theories is reported. Results of Nb crystal work-hardening studies at −196 to 100°C are also reported. The results of these investigations have applications in interpretation of dislocation mechanisms and elevated temperature creep mechanisms. (J.R.D.)

1943 (TID-13887) EFFECT OF ORIENTATION OF THE SURFACE SELF-DIFFUSION OF COPPER. Jei Y. Choi and Paul G. Shewmon (Carnegie Inst. of Tech., Pittsburgh. Metals Research Lab.). [1961]. Contract AT(30-1)-2314. 41p.

The surface self-diffusion coefficient of copper (D_s) was measured between 847 and 1069°C for six different orientations. These were the (111), (110), (100), and three higher index surfaces. The activation energy for D_s (designated Q_s) was found to be about 49 kcal/mol for all six surfaces and D_0 about $2 \times 10^4 cm^2/sec$. At any temperature D_s varied by no more than a factor of three over these orientations. It is shown that, if the free energy of a surface atom is uniquely determined by its number of nearest neighbors, it follows from the principle of microscopic reversibility that Q_s should have the same value for all surface orientations, and D_0 should vary little with orientation. This model also suggests that for clean fcc metals $Q_s \simeq \frac{2}{3}\Delta H_v$ (heat of vaporization). This is true for copper. (auth)

1944 (TID-16455) LOW CYCLE FATIGUE OF PRESSURE VESSEL MATERIALS. Final Technical Report. Volker Weiss, John Sessler, and Paul Packman (Syracuse Univ., N. Y. Research Inst.). June 1962. Contract AT(30-1)-2141. 102p.

The low-cycle controlled strain fatigue behavior of several steel and Al alloys was studied by means of axial tension-compression and bend cycling fatigue tests. The effects of a number of parameters including mean strain, stress biaxiality, superimposed stresses, test temperature, and type of loading were examined systematically. In addition, studies of accumulative and cumulative damage were undertaken in an attempt to gain a deeper understanding of the nature of strain-cycling fatigue and the damage mechanisms that are operative during the life of a strain-cycled specimen. It is shown that low-cycle fatigue phenomena are best analyzed from strain-controlled rather than stress-controlled test data. It is shown that the relationship proposed independently by both Manson and Coffin predicts the failure life of strain-cycled specimens, but only for mean strains equal to zero. A modified equation is proposed which accounts for the effects of mean strain and indicates the equivalence of mean strain and prestrain. Total strain can be utilized instead of the plastic strain components up to approximately 10,000 cycles. Results obtained in tension-compression and in bending are in general agreement if the testing conditions are similar. The effect of both stress biaxiality and superimposed stress is to reduce specimen life at a given strain-cycling level. The latter effect appears to be dependent upon material characteristics. The effect of test temperature can be regarded as a reflection of the effect of temperature on uniaxial fracture ductility. Damage studies indicate that the accumulation of fatigue damage in a strain-cycled specimen is not predictable by the same equations that predict the failure life. Rather, it appears that "accumulated damage" is governed by the loss of available ductility owing to strain hardening and the formation and growth of cracks. Limited studies of "cumulative damage" indicate that subsequent cycling at a strain level higher than a prior precycle strain level results in failure at shorter lives than is predicted by a linear damage assumption. The cumulative damage problem appears to be quite complex. It is suggested that a better understanding of cumulative damage may be gained by the acquisition of additional basic information from accumulated damage studies. This information, obtained under a given set of cycling conditions, might then be translated to various cycling conditions. (auth)

1945 (TID-16879) MEASUREMENT OF EQUILIBRIUM CONCENTRATIONS OF VACANCIES IN COPPER. Technical Report No. 34. R. O. Simmons and R. W. Balluffi (Illinois. Univ., Urbana). Sept. 1962. Contract AT(11-1)-182. 53p.

A report on Cu is presented in which data and other information are given on equilibrium defect concentrations, monovacancy formation energies, monovacancy migration energies, and electric conductivity parameters. Information useful in atomic interpretations concerning annealing of irradiated and cold-worked copper is also included. Results of an investigation devoted mostly to monovacancies are given and compared with those obtained in other investigations. (J.R.D.)

1946 (TID-16980) [PROGRESS REPORT ON] A STUDY OF SURFACE DIFFUSION ON METALS. Paul G. Shewmon (Carnegie Inst. of Tech., Pittsburgh. Metals Research Lab.). Oct. 1, 1962. Contract AT(30-1)-2314. 67p.

The kinetics of grain-boundary grooving on Ag at 750 to 900°C are reported, in which an apparent diffusion coefficient and an activation energy were determined. Information is also presented on the experimental determination of Ag self-diffusion as a function of temperature in pure twist boundaries of varying boundary misorientation. Results of work are included concerning the anisotropy of the surface diffusion coefficient for Cu. A scratch smoothing technique was used in the measurement of Cu surface diffusion coefficients in two orthogonal directions for about 100 different surface orientations. Equations are developed for determination of surface diffusion coefficients for metals when a radioactive point source is used and the solute is drained off from a high-diffusivity surface layer into the metallic lattice. (J.R.D.)

1947 (TID-17174) MECHANICAL PROPERTIES OF ZIRCALOY-2–NIOBIUM–OXYGEN ALLOYS. A. E. Bibb and J. R. Fascia (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 26, 1962. Contract [W-31-109-eng-52]. 30p.

Results of an investigation concerning the effects of temperature on the mechanical properties of Zircaloy-2 containing up to 7.5 wt % Nb and 3500 ppm O_2 are presented. Data are included on strength and ductility at 25 to 850°C. (J.R.D.)

1948 (TID-17182) ELECTRON MICROGRAPHIC AND BOMBARDMENT STUDIES OF ALPHA-LEAD AZIDE. Melvin A. Cook, N. Lawrence Head, Robert T. Keyes, Charles H. Pitt, and Gary M. Thornley (Utah. Univ., Salt Lake City. Inst. of Metals and Explosives Research). [Oct. 1962]. Contract [AT(29-1)-789]. 45p. (SCDC-2889)

Electron micrographs of surface films on α-lead azide formed during the initial portion of the induction period of thermal decomposition together with those obtained by treatment with carbon dioxide and water, nitrogen, oxygen, air, and sodium hydroxide are described. In the case of carbon dioxide and water vapor, characteristic carbonate films were formed. The reaction between α-lead azide and water vapor produced basic lead azide similar to that obtained by treatment of α-lead azide by sodium hydroxide. These reaction products were examined in the electron microscope. The surface of lead azide stored in N_2, O_2, and air were examined but the reaction products were not identified. A method is described for preparing films and microcrystals of lead azide sufficiently thin that they may be viewed by transmission in an electron microscope. Prior to bombardment electron diffraction patterns indicated a crystallite size around 15 Å for these specially prepared films. The mechanisms of lead nuclei growth in electron bombardment were demonstrated visually. Microcrystals of α-lead azide were found to decompose to small lead clumps under strong electron bombardment. Electron diffraction patterns showed also that activated lead formed by evaporation on an inert surface or by nucleation of crystal faces reacted rapidly with the atmosphere to form lead compounds. (auth)

1949 (TID-17206) A PRELIMINARY STUDY OF THIN GADOLINIUM FILMS. Harold J. Peters (Case Inst. of Tech., Cleveland). Aug. 1962. Contract AT(11-1)-623. 45p.

Thin ferromagnetic films of gadolinium were evaporated onto glass substrates. Resistance measurements indicated that these films undergo considerable oxidation at 75°C and 10^{-7} Torr even if coated with magnesium fluoride. X-ray diffraction studies indicated that the films have the HCP structure and show a thickness dependent preferred orientation. The preferred orientation is such that about half the crystallites in the film exhibit a [002] fiber texture with the fiber axis along the substrate normal. Most of the remainder of the crystallites have their [002] poles in or near the surface of the film. (auth)

1950 (TID-17260) POINT DEFECTS IN COPPER (thesis). Robert A. Johnson (Rensselaer Polytechnic Inst., Troy, N. Y.). Nov. 1962. Contract AT(30-1)-1995. 172p.

The atomic configurations and energies for a number of point defects in copper have been theoretically investigated. A semi-empirical model has been used which treats

the crystal in terms of point atoms interacting with two body forces. This model does not account for the change in energy due to the redistribution of electrons in the vicinity of the defect, and a method of calculating this term has been studied. (R.J.S.)

1951 (TID-17276) THE LOW TEMPERATURE OXIDATION OF URANIUM (thesis). William Henry Pfeifer (Ohio State Univ., Columbus). 1962. Contract AT(29-1)-789. 88p. (SCDC-2895)

The oxidation kinetics of uranium in air, dry and moist oxygen, moist nitrogen, and moist hydrogen were determined at 75°C. The oxidation products were examined using x-ray diffraction, and ignition studies were employed to determine the composition of the oxides formed in various moist environments. The effect of surface preparation and roughness on the oxidation rate was determined. (auth)

1952 (UCRL-7028) A NEUTRON DIFFRACTION STUDY OF NiS. Joseph T. Sparks and Ted Komoto (California. Univ., Livermore. Lawrence Radiation Lab.). Oct. 22, 1962. Contract W-7405-eng-48. 8p.

A powder neutron diffraction study of stoichiometric NiS was made in the range 85 to 770°K. The NiAs-type structure can be obtained at room temperature by quenching from above 720°K. This NiAs form exhibits a paramagnetic-antiferromagnetic transition at 263°K. In the antiferromagnetic state the moments in a hexagonal layer are coupled ferromagnetically and point in the direction of the c-axis. The coupling between adjacent hexagonal layers is antiferromagnetic. The sublattice magnetization goes from zero to almost full saturation on cooling through 263°K. The a- and c-axis lattice parameters are also observed to increase abruptly at this temperature. The transition is 3 to 4°K wide and exhibits thermal hysteresis. This transition thus has several characteristics of a first-order transition. (auth)

1953 (UCRL-10441) EFFECT OF SOLUTE ATOMS UPON VACANCY CLIMB OF PRISMATIC DISLOCATIONS IN Al–5% Mg ALLOY. A. Eikum and G. Thomas (California. Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1962. Contract W-7405-eng-48. 26p.

The climb rate of prismatic dislocations in quenched Al–5% Mg Alloy was studied by bulk annealing and also by high-temperature electron microscopy of thin foils. In bulk and thin-foil specimens, loops and helices were always observed to grow. The activation energy was determined to be 0.95 ± 0.05 ev. The results can be interpreted on the basis of a binding energy between vacancies and magnesium atoms which can be ~0.1 to 0.4 ev, depending on their geometrical configuration. (auth)

1954 (UCRL-10457) ANALYSIS OF ENHANCED DIFFUSIVITY IN NICKEL (thesis). Ahmed Rassem Wazzan (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1962. Contract W-7405-eng-48. 71p.

It was found that the coefficient of self-diffusion in nickel single crystals subjected to tensile straining increases with time up to an asymptotic steady state value which is proportional to the strain rate at a constant temperature. At the lower temperature the diffusion coefficient increased greatly with strain rate. It was also found that the coefficient of self-diffusion in prestrained single and polycrystals was independent of the degree of prestrain, and equal to that of the annealed single and polycrystals correspondingly. It was found that the coefficients of self-diffusion in fine-grained ($d \leq 0.1$ mm) nickel crystals over the temperature range 675 to 750°C was a factor 2 to 4 larger than the corresponding coefficients for single crystals. (auth)

1955 (UCRL-10490) EFFECT OF TEMPERATURE ON THE PLASTICITY OF POLYCRYSTALLINE LITHIUM FLUORIDE. D. W. Budworth and Joseph A. Pask (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 8, 1962. Contract W-7405-eng-48. 13p.

Stress-strain curves obtained in bending at temperatures up to 500°C are presented for large-grain specimens of polycrystalline LiF. The amount of plastic strain obtained before fracture is considerably greater at higher temperatures than at room temperature. The grain interactions and dislocation movements involved are discussed, with special reference to the effects of the {100} (110) slip system. (auth)

1956 (WADC-TR-54-276) RESEARCH AND DEVELOPMENT OF WROUGHT AND CAST HIGH TEMPERATURE ALLOYS. R. R. MacFarlane, R. S. DeFries, E. E. Reynolds, and W. W. Dyrkacz (Allegheny Ludlum Steel Corp. Research Dept., Watervliet, N. Y.). Oct. 1954. Contract AF18(600)-149. 97p. (AD-58695)

A study of wrought and cast Co-base and Fe-base alloys was conducted with the object of development of better high-temperature alloys having a minimum strategic alloy content. An alloy containing 10% Ni, 10% Cr, 10% W, 5% Mo, and 1% Nb + Ta was outstanding in rupture properties for the wrought Co-base alloys at 1500 to 1700°F. An 18% Mn, 12% Cr, 3% Mo, 0.8% V alloy had a good combination of properties for application at 1200°F for the wrought Fe-base alloys. Thermal shock properties were best for the cast alloys containing the highest Co. No correlation was apparent between thermal shock characteristics and other commonly measured properties. (auth)

1957 (WAPD-TM-325) SOME INFORMATION ON THE METALLOGRAPHIC APPEARANCE OF HAFNIUM. J. G. Goodwin (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Sept. 1962. Contract AT(11-1)-Gen-14. 34p.

Photomicrographs representing the morphology of hafnium are presented. These micrographs are intended to depict the microstructures most often encountered during the processing of hafnium. A sufficient variety of microstructures is presented so that the appearance of hafnium fabricated in ways not shown can be readily deduced. (auth)

1958 (AEC-tr-5459) STUDIES ON THE VANADIUM–MOLYBDENUM–CARBON SYSTEM. Erwin Rudy, Elisabeth Rudy, and F. Benesovsky. Translated by Gretchen Riese (Los Alamos Scientific Lab., N. Mex.) from Planseeber. Pulvermet., 10: 42-64(1962). 33p.

Data obtained in x-ray and micrographic investigations of C–Mo–V systems are presented. These samples were prepared by hot pressing, vacuum sintering, or arc melting. Effects of U and Th additions are discussed, and structural and phase information is included. (J.R.D.)

1959 (EURAEC-279) BRITTLE FRACTURE STRENGTH OF STAINLESS STEELS. Special Report No. 1, March 1, 1961 to March 1, 1962. (France. Commissariat a l'Energie Atomique, Paris). Includes Appendix. (Institut de Recherches de la Siderugie, St.-Germainen-Laye, France). Feb. 28, 1962. Work performed under United States–Euratom Joint Research and Development Program. Contract 038-60-12 RDF. 118p. A translation.

Activities in a program to develop welded steel products for reactor containment are reported. Efforts during the report period were devoted primarily to defining the approaches now employed in the study of steel fragility phenomena. Information is included which concerns a 2000-ton machine for testing fragile rupture of thick specimens. Results of a survey of tests to evaluate the brittle fracture

strength of welded steel are also included along with data and illustrations concerning fracture technology. (J.R.D.)

1960 (EURAEC-343) DEVELOPMENT OF A MAGNETO-THERMODYNAMIC APPARATUS FOR THE STUDY OF MARTENSITIC TRANSFORMATIONS. Special Report No. 3, January 1–March 31, 1962. (Société des Forges et Ateliers du Creusot, Paris). Work performed under United States–Euratom Joint Research and Development Program. Contract 073-61-12RDF. 25p. A Translation.

An apparatus to detect the appearance of ferromagnetism was developed to measure the temperature at which decomposition of austenite starts and finishes during very rapid cooling. The sample is austenitized in an inert atmosphere by means of a small furnace. It is then suddenly cooled. At the time of the decomposition of the austenite phase, there appears a magnetic phase. The apparatus consists of a holder fixing the sample, a heating assembly, a quenching assembly, a temperature measurement system, and a system for the magnetic detection of transformations. These two measurement systems are connected with the recording assembly by means of two galvanometers and a camera. (M.C.G.)

1961 (EURAEC-344) CONSTRUCTION OF A BED FOR CHARGING STEELS WITH HYDROGEN BY ELECTROLYTIC MEANS. Special Report No. 4, January 1, 1961–March 31, 1962. (Société des Forges et Ateliers du Creusot, Paris). Work performed under United States–Euratom Joint Research and Development Program. Contract 073-61-12-RDF. 21p. A Translation.

An apparatus was constructed for studies of the weakening influence of hydrogen, introduced in protonic form by electrolytic means, on steel. The hydrogen charging bed consists of: 4 charging cells, each capable of holding 1 to 6 test pieces; a current distribution box to feed each test piece with controlled direct current; a cell for the electrolytic polishing of test pieces; and a generating group supplying direct current to the polishing cell. The operating procedure consists of machining the sample, electrolytic polishing, hydrogen charging, and tensile tests. Preliminary tests indicated that the weakening effect of hydrogen is maximum and varies little for nonannealed samples or those annealed at temperature of 250 and 350°C. It then decreased as the annealing temperature increased. (M.C.G.)

1962 (EURAEC-385) RARE-GAS DIFFUSION IN SOLIDS. Quarterly Report No. 4 (2nd year), April 1 to June 30, 1962. (Hahn-Meitner-Institut für Kernforschung, Berlin). Work performed under United States–Euratom Joint Research and Development Program. Contract 064-61-8-RDD. 6p. A translation.

Measurements were made of the diffusion of Ar in KCl at 400 to 700°C. A straight line was obtained by plotting a^2 vs t. A diffusion test was carried out on Xe in uranium oxide with heating at 700, 1400, and 1700°C. The xenon-diffusion effects on powdered UC were examined at constant temperature in the 1100 to 1800°C range. The release occurred in each case in a single activity impulse and a subsequent linear section in the F over $\sqrt{t}$ diagram. (M.C.G.)

1963 (FTD-TT-62-1256) NIOBIUM AND ITS ALLOYS G. B. Zakharova, D. B. Mishina, and E. Ya. Velmozhnyi (Velmozhnyy). Translated from Tsvetn. Metal., No. 4, 88-92(1962). 11p.

The development and applications of niobium alloys in the U. S. and England are discussed. Chemical composition, mechanical properties, heat resistance, elasticity, recrystallization conditions, and physical properties of the alloys developed are described. (M.C.G.)

1964 X-RAY DIFFRACTION STUDY OF PRECIPITATES FORMED DURING THE BOMBARDMENT OF CERTAIN METALS BY THE IONS OF OTHER METALS. V. Ya. Dudarev, G. S. Zhdanov, and B. A. Alekseev. At. Energ. (USSR), 13: 382-3(Oct. 1962). (In Russian)

Bombardment of metals by ions having energies of several tens of kev, as in the case of electromagnetic isotope separation machines, results in the pulverization of the metal and subsequent deposition of the powder on the surrounding areas. Such deposits, formed during the bombardment of Cu with 30-kev Sn^+, Zr^+, and Mg^+ and of Al by Zr^+ were examined by x-ray-diffraction and chemical methods. The Cu + Sn system was found to be harder and more brittle than pure Cu; its x-ray diagram indicated that it has the same crystal structure as Cu although the diffraction lines are less sharp and were shifted toward lower Θ angles. The concentration of the solid solutions formed varied with the depth of the layer: the bottom layer contained 2.5, the top one 1.8 at.% of Sn. The Cu + Zr system also formed Cu-based solid solution with an average Zr content of 5.29 at.%; a small amount of the compound Cu_3Zr could also be detected. The Cu + Mg deposits, consisting of a solid solution of Mg in Cu, had a higher hardness and elasticity than Cu. The average Zr content of the Al + Zr system was 18.09 wt.%; widening of the lines also indicated the formation of a solid solution; some lines pointed to the presence of a compound. Thus, all the deposits consisted of solid solutions with relatively low concentration of the bombarding ions. (TTT)

1965 CERAMIC FIBERS. W. L. Lachman and J. P. Sterry (H. I. Thompson Fiber Glass Co., Gardena, Calif.). Chem. Eng. Progr., 58: 37-41(Oct. 1962).

A discussion is presented of the state-of-the-art of ceramic fibers for fibrous reinforcements in composites. The major types of ceramic fibers are outlined. It is shown that polycrystalline, continuous fibers show the most promise. (D.L.C.)

1966 DETERMINATION OF THE DIFFUSION PARAMETERS OF HYDROGEN IN IRON AND EXTRA-SOFT STEEL. Jacques Plusquellec, Henri Veysseyre, Pierre Azou, and Paul Bastien (École Centrale des Arts et Manufactures, Paris). Compt. Rend., 255: 518-20(July 16, 1962. (In French)

An unpublished method for the determination of the constant D_0 and the activation energy ϵ for the diffusion of hydrogen into iron was perfected. It consists essentially in the realization, on a test piece charged with hydrogen under definite condition, of a linear program of temperature rise at low velocity. (tr-auth)

1967 THERMAL EXPANSION OF VANADIUM, NIOBIUM, AND TANTALUM AT LOW TEMPERATURES. G. K. White (Commonwealth Scientific and Industrial Research Organization, Sydney). Cryogenics, 2: 292-6(Sept. 1962).

Thermal expansion measurements are reported for V, Nb, and Ta at 1 to 30°K, 75, 85, and 280°K in zero magnetic field. Measurements below 10°K in transverse magnetic fields were also made for V and Ta. Calculations were made on Grueneisen parameter $\gamma = \beta VK/C$, where β = cubic thermal expansion coefficient, V = atomic volume, K = bulk modulus, and C = specific heat. Values were derived for the pressure dependence of the critical field, $\partial H_c/\partial p$, and were extrapolated to T = 0 and T_c. (D.L.C.)

1968 THE EFFECT OF ALUMINUM ON THE STABILITY OF THE BETA PHASE IN Ti–Mo–Fe ALLOYS. N. V. Ageev, L. P. Grankova, and P. K. Novik (Baikov Inst. of Metallurgy, Academy of Sciences, USSR). Doklady Akad. Nauk SSSR, 146: 351-4(Sept. 11, 1962). (In Russian)

Ti–Mo–Fe alloys containing 1, 2, and 3% Al by weight were prepared by pressing out a pellet of the mixed ingredients and then fusing in a vacuum arc furnace with a tungsten electrode in an atmosphere of argon or helium. The fusion was repeated 3 to 4 times. The samples were forged into bars at a temperature of 750 to 950°C, and annealed for two hours at 900°C. The annealed samples were quenched from temperatures of 700 to 1000°C. The alloys contained 6.7 to 13.5% Mo, 2.2 to 10% Fe, and 1, 2, or 3% Al with the remainder being Ti. All the alloys, with the exception of the 6.7% Mo–2.2% Fe alloy containing 1, 2, and 3% Al, showed the single-phase structure of a solid β-solution on quenching from 700°C. The quenched alloys were aged at 200 to 600°C for 0.25 to 144 hours. On heating for 15 minutes at 200°C, the β-phase of Ti-6.7% Mo–2.2% Fe alloy (formed by quenching from 900 to 1000°C) broke down into an ω-phase, as shown by an increase in hardness. The transition $\beta + \omega \rightarrow \beta + \alpha$ took place at 400°C after 25 hours aging. The β-phase broke down directly to the α-phase with no intermediate formation of an ω-phase. The β-phase was stable at 300°C for 100 hours in all alloys. In Ti-12% Mo-10% Fe alloys containing 1, 2, and 3% Al, the β-phase was stable for 144 hours. In Ti-9% Mo–10% Fe alloys containing 1, 2, and 3% Al, the β-phase broke down in 121, 25, and 16 hours respectively at 400°C. The alloy broke down in 15 minutes at 500°C. The stability of the β-phase decreased with increasing aluminum content. (TTT)

1969 DEFORMATION BEHAVIOR OF POLYCRYSTALLINE ALUMINUM OXIDE. Stanley I. Warshaw and Frederick H. Norton (Massachusetts Inst. of Tech., Cambridge). J. Am. Ceram. Soc., 45: 479-86(Oct. 1962).

The steady-state creep behavior of polycrystalline aluminum oxide from 97 to 100% density was examined at temperatures from 1600 to 1800°C over a range of stresses from 100 to 2000 psi under four-point transverse bending. Grain size is shown to have an important effect on the deformation behavior. Stress-strain rate dependence for the fine-grained aluminum oxide (3 to 13μ) is of viscous behavior ($\dot{\epsilon} \sim \sigma$). The strain rate is also inversely proportional to the square of the grain size ($\dot{\epsilon} \sim 1/(GS)^2$). The creep behavior can be described by the Nabarro-Herring diffusional flow model although the diffusion coefficient does not agree with that for oxygen diffusion in sapphire. When the grain size becomes coarse, the Nabarro-Herring model no longer applies. Coarse-grained aluminum oxide (50 to 100μ) behaves plastically when deformed ($\dot{\epsilon} \sim \sigma^4$). The strain rates observed on coarse-grained aluminum oxide are higher than one would predict from the deformation behavior of fine-grained aluminum oxide. This plastic flow probably occurs through some dislocation movement or glide mechanism. (auth)

1970 SOLID SOLUTIONS BASED ON FERROELECTRIC $PbNb_2O_6$. E. C. Subbarao and J. Hrizo (Westinghouse Research Labs., Pittsburgh). J. Am. Ceram. Soc., 45: 528-31(Nov. 1, 1962).

An x-ray and dielectric study of three series of $PbNb_2O_6$-type solid solutions was carried out. The $PbNb_2O_6$-type phase was present up to the following limits: $(Pb_{1-x}Bi_x)(Ti_xNb_{2-x})O_6$, x = 0.2; $(Pb_{1-x}Bi_{x/3})(Ti_xNb_{1-x})_2O_6$, x = 0.2; and $(Pb_{1-x}Bi_{x/3})Nb_2O_6$, x = 0.3. Orthorhombic distortion b/a and Curie temperature decreased with increasing x. $Bi_{2/3}$–Ti_2O_6 was most effective in this respect and $Bi_{2/3}$–Nb_2O_6 had the least influence. The important role played by ions of different valency located on crystallographically equivalent sites is pointed out. (auth)

1971 THERMAL-EXPANSION ANISOTROPY OF OXIDE SOLID SOLUTIONS. Kenneth M. Merz, W. Richard Brown, and Henry P. Kirchner (Cornell Univ., Buffalo). J. Am. Ceram. Soc., 45: 531-6(Nov. 1, 1962).

The effect of solid-solution atoms on the thermal-expansion anisotropy of some oxides was studied. The importance of solid-solution atoms in determining the thermal-expansion anisotropy of rutile, SnO_2, corundum, and Cr_2O_3 solid solutions was demonstrated. Vanadium additions to rutile are particularly effective in reducing thermal-expansion anisotropy. The thermal-expansion anisotropy was determined by x-ray diffraction techniques in the temperature range room temperature to 1000°C. Information relating to the extent of solid solution of vanadium in rutile is presented. (auth)

1972 STRENGTH AND STRUCTURE OF REFRACTORIES AS A FUNCTION OF PORE CONTENT. L. J. Trostel, Jr. (Norton Co., Worcester, Mass.). J. Am. Ceram. Soc., 45: 563-4(Nov. 1, 1962).

The effects of porosities as high as 90% of the total volume on the strength and structure of sintered zirconia and alumina bodies were studied. The oxides were composed of -44μ material with induced pores about 2500μ in average diameter. At porosities below 50%, the residual porosity in the mixtures themselves contributed significantly to total porosity. At the lowest porosity values (20% for zirconia and 26% alumina) the porosity was entirely residual with no induced pores. Alumina and zirconia showed similar structures for similar porosities. (P.C.H.)

1973 REMARKS ON THE MELTING POINT OF TECHNETIUM AND THE PERIODICITY OF THE MELTING POINTS OF TRANSITION METALS. Z. G. Szabó and B. Lakatos (Univ. of Szeged, Hungary). J. Inst. Metals, 91: 117(Nov. 1962).

Differences in calculations of melting points for Tc, Os, and Re are discussed, along with similarity between the melting-point curves for the elements of Period VI and those of Periods V and IV. (P.C.H.)

1974 APPLICATION OF CATHODIC OXIDATION TO THE METALLOGRAPHIC INVESTIGATION OF URANIUM GROUND SPECIMENS. R. Czarnecki and F. Hilbert (Zentralinstitut fur Kernphysik, Rossendorf, Ger.). Kernenergie, 5: 566-70(July 1962). (In German)

The effect of various physical and chemical factors on the oxidation process on ground U samples was studied. The experimental investigations were carried out on cast and α-treated samples and on deformed α- and β-treated natural uranium metal. No essential differences in the behavior of the samples with different preliminary treatments were found. The following factors play the principal roles for the favorable pattern of the process: the condition of the surface after the polishing process, the ion energy, and the vacuum conditions. (tr-auth)

1975 SELECTION AND FABRICATION OF CERAMICS AND INTERMETALLICS. John D. Latva (Aeronautical Systems Div., Wright-Patterson AFB, Ohio). Metal Progr., 82: No. 4, 139-44; 180; 186(Oct. 1962).

Knowledge of the brittle fracture properties of refractory ceramics is necessary for space vehicle and weapons applications. The properties of borides, carbides, and nitrides are reviewed together with their advantages and disadvantages for these applications. (D.L.C.)

1976 THE AGING SEQUENCE IN AN ALUMINUM–ZINC–MAGNESIUM ALLOY. J. Ramesam, M. Ramakrishna Rao, and T. R. Anantharaman (Indian Inst. of Science, Bangalore). Naturwissenschaften, 49: 344(1962). (In English)

A study was made to determine the possibility of obtaining satisfactory oxide replicas of Al–Zn–Mg alloys for exami-

nation in a 100 kv Phillips electron microscope. To obtain the replicas the alloy specimens were electropolished, etched, oxidized anodically, and stripped of the oxide film. The electron micrograph displayed good resolution. The precipitation process in a high purity Al–Zn–Mg alloy at 100°C seems to consist essentially of a formation of spherical zones and their steady growth or coalescence into bigger particles (up to about 1000 Å). Typical electron micrographs of oxide replicas after various heat treatment are shown. (J.S.R.)

1977 THE DEVELOPMENT OF HIGH PURITY TANTALUM AND ALLOYS FOR LIQUID PLUTONIUM CONTAINMENT IN LAMPRE I. Richard M. Bidwell, William E. Ferguson, Calvin C. Burwell, R. Philip Hammond, Keith V. Davidson, Walter R. Wykoff, and Robert W. Anderson (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 14: 109-22(Oct. 1962).

By combining arc casting and electron beam melting, spectroscopically pure tantalum and alloys were produced, suitable for containment of molten Pu–Fe alloys. The 0.1% W alloy was used for the first LAMPRE loading. The effects of a large number of additives on the corrosion resistance of tantalum were tested. Additions of up to 10% tungsten gave increasing endurance. Specimens of tantalum irradiated with neutrons to give 3% conversion to tungsten were still satisfactory in mechanical properties for reactor use. Either tungsten addition or traces of yttrium raise the one-hour recrystallization temperature of tantalum by 400°C. Effects of internal strain, critical strain, and precipitation hardening in tantalum alloys were studied. High-temperature annealed tantalum had superior corrosion resistance to the fuel, while impact-extruded and ironed material was better than deep-drawn metal. Mechanical tests on tantalum with added interstitial elements showed that their presence to the extent expected in LAMPRE would be unlikely to weaken the tantalum. While small amounts of hydrogen, nitrogen, and carbon in the tantalum had no effect on corrosion, oxygen was found to promote plutonium attack on the metal. (auth)

1978 APPARENT BOILING OF URANIUM OXIDE IN THE CENTER OF A FUEL PIN DURING TRANSIENT POWER GENERATION. J. H. Field, F. J. Leitz, M. J. McNelly, and R. C. Nelson (General Electric Co., San Jose, Calif.). Nucl. Sci. Eng., 14: 210-11(Oct. 1962).

Power excursion tests for the development of ceramic fuels for the Fast Ceramic Reactor concept are described which indicate that UO_2 in a large portion of the test fuel pin reaches its boiling point. Stainless steel-clad UO_2 was found to withstand a transient which took it up to a maximum of 7000°F, but a significant pressure surge was observed. Large bubbles were formed along with finely dispersed bubbles, and grain growth within 10 to 50 mils of the clad is evident, although the temperature there is estimated to be >3000°F for less than 30 sec. It is concluded that the transient maximum fuel temperature threshold for UO_2 is in excess of 7000°F. (D.L.C.)

1979 THE EXPERIMENTAL DETERMINATION OF THE THERMOELECTRIC POWER IN LIQUID METALS AND ALLOYS. C. C. Bradley (Royal Society Mond Lab., Cambridge, Eng.). Phil. Mag. (8), 7: 1337-47(Aug. 1962).

The thermoelectric power in the liquid state was measured as a function of temperature for ten pure metals (Na, K, Rb, Cd, Hg, In, Ga, Sn, Pb, Bi) with valences from one to five and melting points below 500°C, and nine Na–K and Rb–K alloys. Use was made of a recently established absolute thermoelectric scale which is more reliable than previous ones. The theoretical aspects of the results for the pure metals are described briefly in terms of electron scattering by pseudo-potentials and density fluctuations in the liquid. For the alloy results, an interpretation based on similar theories is given. The scattering mechanism of impurities depends on their size and pseudo-potentials. It is concluded that the size effect dominates in Na–K alloys, and that both are significant in Rb–K alloys. (auth)

1980 SELF-DIFFUSION IN PLATINUM. F. Cattaneo (CISE, Milan), E. Germagnoli, and F. Grasso. Phil. Mag. (8), 7: 1373-83(Aug. 1962).

Self-diffusion coefficients in platinum were measured, in the temperature range between 1250 and 1725°C, by measuring the decrease of activity at the surface of the specimen during diffusion. The experimental results can be summarized by the following relationship: $D = 0.22 \exp(-2.89 \text{ ev/kT}) \text{ cm}^2 \text{ sec}^{-1}$. The consistency of self-diffusion data with the results from quenching and annealing experiments with pure platinum is discussed. (auth)

1981 COMPOUNDS OF THE W_6Fe_7 TYPE IN THE Ta–Ni AND Nb–Ni SYSTEMS. P. I. Kripyakevich, E. I. Gladyshevskii, and E. N. Pylaeva (Franko State Univ., L'vov). Soviet Phys.-Cryst. (English Transl.), 7: 165-8(Sept.-Oct. 1962).

TaNi has a structure of the W_6Fe_7 type and is isostructural with the compound between Nb and Ni that has roughly the composition NbNi. (auth)

1982 AN X-RAY INVESTIGATION OF SUPERCONDUCTING ALLOYS OF BISMUTH WITH PLATINUM IN THE RANGE 20–640°C. N. N. Zhuravlev and A. A. Stepanova (Moscow State Univ.). Soviet Phys.-Cryst. (English Transl.), 7: 241-2(Sept.-Oct. 1962).

X-ray photographs were made of PtBi and $PtBi_2$ at temperatures up to 640°C. The lattice constants of PtBi at room temperature were found to be 4.315 and 5.490 Å. Thermal expansion coefficients were calculated from the lattice constants. PtBi retains the nickel arsenide type structure up to 600°C, and on heating in vacuum, some of the Bi evaporates. Three modifications of $PtBi_2$ were found. The thermal expansion coefficients showed a large anisotropy for PtBi, a small reverse anisotropy for Bi, and a small value for α-$PtBi_2$. (D.L.C.)

1983 ALLOYS OF BISMUTH AND ANTIMONY WITH SCANDIUM. N. N. Zhuravlev and E. M. Smirnova (Moscow State Univ.). Soviet Phys.-Cryst. (English Transl.), 7: 243-4(Sept.-Oct. 1962).

Bi–Sc and Sb–Sc alloys were investigated in a search for new superconducting compounds. ScBi and ScSb crystals were formed on addition of Sc to Bi and Sb, respectively. ScBi is unstable in air, breaking down to give Bi, while ScSb is stable in air. X-ray studies showed that both ScBi and ScSb are of the cubic NaCl structure, with the respective lattice constants $a = 5.954 \pm 0.006$ and 5.838 ± 0.006 Å. The ionic bond character and minimum Bi-Bi distances indicate that ScBi is not superconducting. (D.L.C.)

1984 VISUALIZATION OF INTERNAL STRUCTURE IN METALS USING NEUTRON RADIOGRAPHY. Harold Berger (Argonne National Lab., Ill.). Trans. Am. Soc. Metals, 55: 251-4(Mar. 1962). (TID-13235; ANL-FGF-262)

Unusual patterns were observed in neutron radiographs of a nickel disk, cut from a ¾ in. diam cast rod. It was found that areas of differing cross section within the nickel, due to changes in crystal orientation and grain size, were being observed. Pictures demonstrating the effect that neutron transmission through metals having interplanar spacings in the same order as the neutron wave length will increase with grain size are presented. Differences in

structure found in the nickel rod and improved image quality which can be obtained on the neutron radiographs by employing slower, finer-grain film and longer exposures are demonstrated. A note on the technique used is also included. (P.C.H.)

1985 SOLUBILITY OF 3-d TRANSITION METALS IN LIQUID CADMIUM. M. G. Chasanov, P. D. Hunt, I. Johnson, and H. M. Feder (Argonne National Lab., Ill.). Trans. Met. Soc. AIME, 224: 935-9(Oct. 1962). (TID-14623)

The solubilities of the transition metals from scandium to nickel, inclusive, in liquid cadmium were determined by sampling saturated solutions. At 400°C these solubilities (in ppm) are: Sc, 8200; Ti, 150; V, <0.2; Cr, 2; Mn, 2500; Fe, 1; Co, 22; Ni, 12000. Relative partial molal enthalpies and excess partial molal entropies at infinite dilution for the solutes Cr, Mn, Fe, and Co are compared with similar data for the post-transition metals. Three new intermetallic phases, $ScCd_3$, TiCd, and Ti_2Cd, encountered in the course of this work, are reported. (auth)

1986 THE SOLUBILITY OF LITHIUM IN ALUMINUM. L. P. Costas and R. P. Marshall (E. I. du Pont de Nemours and Co., Aiken, S. C.). Trans. Met. Soc. AIME, 224: 970-4(Oct. 1962).

The solid solubility of lithium in aluminum was determined by two independent techniques, electrical resistivity and microhardness, and the results are in close agreement. The solubility limits at 200, 300, 400, 500, and 600°C were found to be 6.0, 7.1, 8.5, 10.8, and 13.7 at. %, respectively. X-ray-diffraction studies of the intermetallic compound LiAl indicate that its composition is nearly independent of temperature when in equilibrium with the terminal solid solution of aluminum. (auth)

1987 THE PRECIPITATION OF METASTABLE ALPHA PHASE DURING THE GAMMA TO GAMMA PRIME TRANSFORMATION IN URANIUM-16 wt pct MOLYBDENUM. D. Kramer and C. G. Rhodes (Atomics International, Canoga Park, Calif.). Trans. Met. Soc. AIME, 224: 1015-20(Oct. 1962).

The kinetics of precipitation of transient α phase during the γ-to-γ'-transformation in U-16 wt % Mo between 400 and 550°C were studied using quantitative metallography and electrical resistivity measurements. The volume percent of α phase goes through a maximum in time, corresponding to a critical degree of progress of γ' formation, prior to its re-solution after prolonged annealing. The fastest rate of α precipitation occurs at 500°C with a concomittant lowest peak of 9.5 vol % α. At 450°C, 14 vol % α, greatest for any temperature, was observed after 24 hr with an associated slowest rate of formation. α precipitation at 400°C ceases after approximately 160 hr, and the amount of α present remains unchanged after long times at temperature; no γ' was observed metallographically at this temperature. (auth)

1988 INTERMEDIATE PHASES INVOLVING SCANDIUM. A. T. Aldred (Argonne National Lab., Ill.). Trans. Met. Soc. AIME, 224: 1082-3(Oct. 1962). (ANL-FGF-333)

The existence of several new intermetallic compounds of the Sc_2B and ScB stoichiometries, where B is from group VIII or IB of the periodic table, is reported along with their structures and lattice parameters. The Sc_2B compounds include Sc_2Ni, Sc_2Pd, Sc_2Co, and Sc_2Au, while the ScB compounds are ScCo, ScNi, ScCu, ScRu, ScRh, ScPd, ScAg, ScIr, ScPt, and ScAu, all of the ordered bcc CsCl structure. The trends in a plot of lattice contractions of the ScB compounds are discussed. (D.L.C.)

1989 INVESTIGATIONS ON THE SUPERCONDUCTIVITY IN THE NIOBIUM-ALUMINUM SYSTEM. K. Raetz and E. Saur (Universität Giessen, Ger.). Z. Physik, 169: 315-22(Aug. 1962). (In German)

Superconductivity measurements on Nb-Al were reported. The samples were prepared by fusion and sintering in the form of thin surface layers by diffusion of aluminum into niobium. The previously determined values for the transition temperature of the intermetallic compound Nb_3Al was confirmed between 16.8 and 18°K. Measurements in the magnetic field gave, for the initial increase of the critical field curve of a sintered Nb_3Al sample, values of approximately 40 kOe/°K, which can lead to a compressed filament structure of the sintered samples. (tr-auth)

1990 PARAMAGNETIC RESONANCE OF THE Cr^{3+} ION IN SPINEL. V. A. Atsarkin (Inst. of Radiotechnology and Electronics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 43: 839-40(Sept. 1962). (In Russian)

Results of investigation of paramagnetic resonance of the chromium ion in spinel are presented. Spin Hamiltonian constants are found which sharply differ from those cited by Stahl-Brada and Low. From the dependence of the line width on orientation in a magnetic field it is concluded that the magnesium and aluminum ion distribution in spinel is disordered. (auth)

1991 CONSTITUTION DIAGRAM OF Hf-Re ALLOY. E. M. Savitskii, M. A. Tylkina, I. A. Tsyganova, E. I. Gladyshevskii, and M. P. Mulyava (Baikov Inst. of Metallurgy and Franko L'vov State Univ., USSR). Zh. Neorgan. Khim., 7: 1608-10(July 1962). (In Russian)

Microstructure, microhardness, and x-ray diffraction analyses were made, and the constitution diagram for Hf-Re, demonstrating three metallic compounds, was constructed. The solubility of Re in α Hf is less than 3 wt. % at 1250°C (with 3 wt.% Hf it is a two-phase alloy). Additions of Re to Hf partially stabilize the β phase and reduce the temperature of polymorphous transformation to 1250°C. A second intermetallic compound, $HfRe_2$, with a structure resembling the $MgZn_2$ structure, is formed at 2850°C. The third compound formed at 2280°C resembles Zr_3Re in structure. The microhardness of Hf_3Re_2 is 1000 kg/mm^2. (R.V.J.)

1992 INVESTIGATIONS OF TIN BASE Sn-Ti ALLOYS. V. N. Eremenko and T. Ya. Velikanova. Zh. Neorgan. Khim., 7: 1750-2(July 1962). (In Russian)

The structure and properties of tin with 0 to 20 wt.% Ti were studied. The addition of Ti reduces the crystallization temperature. The diffusion of Ti in Sn solid solution is very low, 0.008 to 0.006 wt.% Ti. A non-variant transformation takes place in alloys containing 8.3 to 34.6 wt.% Ti at 790°C. The nature of the transformation was not determined. (R.V.J.)

1993 CONSTITUTION DIAGRAM OF Sc_2O_3-SiO_2 SYSTEM. N. A. Toropov and V. A. Vadil'eva. Zh. Neorgan. Khim., 7: 1938-45(Aug. 1962). (In Russian)

A constitution diagram was constructed for Sc_2O_3-SiO_2. The melting point for Sc_2O_3 was found at 2470°C and the pycnometric density was 3.860 g/cm^3. The crystal structure was analyzed. (R.V.J.)

1994 SOLID PHASE REACTIONS IN SrO-TiO_2-ZrO_2. Kh. Sh. Iskhakov and E. K. Keler (Inst. of Chemistry of Silicates, Academy of Sciences, USSR). Zh. Neorgan. Khim., 7: 1946-57(Aug. 1962). (In Russian)

Phase studies were made of SrO-TiO_2-ZrO_2 at 1200 to 1700°C. It is shown that the $SrTiO_3$ and $ZrTiO_4$ (formed at 1200 to 1300°) form continuous solid solutions with cubic structure at 1200 to 1400°C. Compounds containing more than 50 mole % TiO_2 melt at 1400°. Mixtures rich with SrO

(over 50 mole %) form first Sr_2TiO_4, then $SrTiO_3$ and $SrZrO_3$. (R.V.J.)

1995 FORMATION AND ELECTRIC PROPERTIES OF SOLID SOLUTIONS OF $SrTiO_3$–$SrZrO_3$. Kh. Sh. Iskhakov and E. K. Keler (Inst. of Chemistry of Silicates, Academy of Sciences, USSR). Zh. Neorgan. Khim., 7: 1958-63(Aug. 1962). (In Russian)

X-ray diffraction analysis revealed a cubic structure for $SrTiO_3$–$SrZrO_3$ solid solutions at 1150°C. The solid solutions possess a high dielectric penetrability, negligible dielectric losses, and negative TKϵ. With increased $SrZrO_3$ concentrations the ϵ slowly diminishes and TKϵ increases. (R.V.J.)

1996 MECHANISMS OF THE ELECTRICAL RESISTIVITY OF RARE EARTH ALLOYS AT LOW TEMPERATURES. Fred August Smidt, Jr. Thesis, Ames, Iowa State Univ. of Science and Tech., 1962. 176p.

The existence of complete solid solubility in the alloy systems Gd–Lu, Tb–Lu, and Gd–Er was established by means of x-ray diffraction and electrical resistivity methods. The electrical resistivity was measured as a function of temperature from 4.2 to 310°K for twelve alloys in these systems and the data were analyzed to obtain the magnetic ordering temperatures, spin disorder resistivities, and the residual resistivities as a function of composition, and the temperature dependence of the resistivity in the low temperature region. The magnetic ordering temperatures were found to vary approximately linearly with composition, the spin disorder resistivities varied as $(g-1)^2 J(J+1)$ with a general correlation between the $(g-1)^2 J(J+1)$ value for an alloy and a metal with the same $(g-1)^2 J(J+1)$ value, and the residual resistivities were found to follow Nordheim's rule. The residual resistivities of the Gd–Lu alloys were found to be about three times larger than would be expected from simple alloy disorder effects and the additional contribution was attributed to a disorder of magnetic ions in the lattice. This is another manifestation of the s-f interaction in rare earth metals previously found to influence the magnetic ordering temperatures, the spin disorder resistivities, and the superconducting transition temperature of lanthanum alloys. A series of dilute alloys of lutetium with various heavy rare earth metals as solutes was prepared, and the electrical resistivity of the alloys measured at 4.2°K to characterize this effect. The results provided the first experimental distinction between the spin dependence $(g-1)^2 J(J+1)$ predicted by de Gennes and Brout and Shul and the closely related spin dependence $S(S+1)$. The magnitude of the exchange integral was evaluated from the experimental data by use of Kasuya's equations and found to be 0.45 ev. Analysis of the published data on the pure metals showed the temperature dependence of the resistivity at low temperatures for Gd, Tb, and Dy to be in agreement with the T^2 dependence predicted from a spin wave model for a ferromagnetic metal and that of thulium to agree with the T^4 dependence predicted for an antiferromagnetic metal. The values of the parameter R, related to the Fermi surface area as described by Ziman, were calculated for the rare earth metals and compared with the published values for other metals. The variation of R within the heavy rare earth sub-group was found to be correlated with the c/a ratio for these metals. (Dissertation Abstr., 23: No. 3, 1962)

1997 IRON–ALUMINIUM BASE ALLOYS. (to U. S. Atomic Energy Commission). British Patent 907,731. Oct. 10, 1962.

Fe–Al base alloys are described which have improved ductility and fabricability even after high-temperature annealing, and increased resistance to water corrosion. The alloys comprise by weight 6 to 10% Al, 2 to 5% Cr, 1 to 5% Nb, 0.5 to 3% Zr, and balance Fe; 0 to 4% Mo and 0 to 2% Ti may also be included. The effects of Zr on the ductility, stress-rupture life, and corrosion resistance of the alloys are shown. (D.L.C.)

1998 COLUMBIUM BASE ALLOY. Jack W. Clark (to General Electric Co.). U. S. Patent 3,056,672. Oct. 2, 1962.

A Nb-base alloy is described which has good oxidation resistance, high creep strength, and good low-temperature ductility. The alloy comprises 20% W, 0.5 to 2% Zr or Hf, 0.01 to 0.2% C, and balance Nb; the atomic ratio of Zr or Hf to C must be in the range of 0.5 to 1.5. The effects of the Zr/C ratio on the creep rate of Nb–20% W alloys containing 1.0 and 0.5% Zr are shown. (D.L.C.)

Radiation Effects

1999 (AAEC/E-96) THE IRRADIATION BEHAVIOUR OF BERYLLIUM BASED DISPERSION FUELS—A PRELIMINARY IRRADIATION EXPERIMENT. G. L. Hanna, B. S. Hickman, and R. J. Hilditch (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Sept. 1962. 33p.

The effects of fission-fragment damage on vacuum-hot-pressed fuel specimens of $(U,Th)Be_{13}$ dispersed in a beryllium matrix were examined by irradiation in a predominantly thermal neutron flux. Damage equivalent to that caused by 4×10^{19} to 11×10^{19} fissions per cm^3 (depending on specimen composition) was achieved at temperatures between 435 and 530°C. All specimens increased in volume on irradiation. The increases ranged from 0.1 to 5%, depending on the volume fraction of fuel phase and the number of fissions per cm^3. Some of the volume change, possibly up to 0.7%, was due to thermal effects alone. Release of fission gases was as high as 2% in some cases and was generally higher than would be expected from recoil in specimens having no open porosity. The fractional release was greater in specimens which experienced a high volume increase. Microstructures showed no significant change on irradiation. All specimens were slightly porous before irradiation, and it is considered that the swelling of specimens was due to the growth of existing pores and that the release of fission gases was facilitated by an increase in open porosity. (auth)

2000 (BMI-B&W-654) THE EFFECTS OF IRRADIATION ON TYPE 304 STAINLESS STEEL CONTAINING MINOR BORON ADDITIONS. Sam Alfant, Frederic R. Shober, and Ronald F. Dickerson (Battelle Memorial Inst., Columbus, Ohio). Dec. 22, 1959. 28p.

The tensile properties and the hardness before and after irradiation of type 304 stainless steel containing 0, 300, and 500 ppm natural B were determined at room temperature. The tubular tensile specimens were exposed to 9.75×10^{19} nvt (total integrated thermal flux) and to 4.00×10^{18} nvt (total fast flux) during irradiation. The major changes in properties produced by irradiation were evident in the increased yield strength, from 40,000 psi to 80,000 psi, and in the reduction of total elongation, from 55 to 35%. The effects of natural B were most noticeably reflected in an increase of the yield strength in the irradiated specimens with increased B content. (auth)

2001 (BNL-6375) DYNAMICS OF RADIATION DAMAGE: A REPORT ON RECENT RESULTS AT BNL. George H. Vineyard (Brookhaven National Lab., Upton, N. Y.). Contract [AT-30-2-GEN-16]. 20p.

Machine calculations were made of the dynamics of a set of atoms simulating a crystal undergoing radiation damage. Work on copper is reviewed briefly, and its extension to a simple model of ordered Cu_3Au is described. Investigations of lattice agitation in the wake of a damage event and the extent to which a thermal spike model has validity are discussed. Information on point defects and clusters of point defects in copper is another by-product of the calculations. Recent extensions of the calculations to a model of α-iron are reported. Although a satisfactory interatomic potential was not found, it appears that the easy direction for production of a displacement is (100) and that the interstitial in this lattice has a split configuration with (110) orientation. (auth)

2002 (CRRM-1097) THE IRRADIATION OF ALUMINUM–PLUTONIUM ALLOYS IN ZIRCALOY-2 SHEATHING. PART III. POST-IRRADIATION EXAMINATION AND TESTING OF ALUMINUM–PLUTONIUM ALLOYS. T. I. Jones (Atomic Energy of Canada Ltd., Chalk River, Ont.). July 1962. 30p. (AECL-1589)

Ten 0.36-in. diameter aluminum alloys containing 5 to 20 wt % plutonium sheathed in 0.030-in. thick Zircaloy-2 cans were irradiated without incident for four months under water-cooled power reactor conditions in the X-2 loop of the NRX reactor. Six of the elements were assembled with a slip fit between the sheath and fuel so that the fuel underwent irradiation at ~400°C. Volume changes and sheath/fuel interaction were insignificant after 0.25% of the total atoms present had fissioned. The tests showed, therefore, that Al–Pu alloys are dimensionally stable and highly compatible with Zircaloy-2 under conditions appropriate to water-cooled power reactors. Four elements were assembled also with diametral clearances between the fuel and sheath. Initially these elements were irradiated at ~600°C but this temperature was reduced during irradiation due to swelling. The cores in these elements increased in volume by up to 6%. Relatively good agreement was obtained between three methods of measuring plutonium burn-up. Sheath puncture tests and measurements on Cs^{137} collected from the internal surfaces of two specimens showed that very little diffusion of fission products occurred through the fuel to the sheath/fuel interface during irradiation. Metallographic, hardness and density changes after irradiation and post-irradiation annealing are described. (auth)

2003 (HW-64590(Rev.3)) POST-IRRADIATION FUEL ELEMENT EXAMINATION DATA. J. M. Fouts (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 3, 1961. Contract AT(45-1)-1350. 12p.

A data sheet is described which can be used in machine processing of post-irradiation fuel element examination results. A sample specimen of the data sheet is included along with a tabulation of nomenclature for use with the sheet. (J.R.D.)

2004 (NP-12180) RADIATION DAMAGE TO SILICON. Second Semiannual Report, January 1, 1962–July 15, 1962. J. A. Baicker, B. W. Faughnan, and J. J. Wysocki (National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.). July 31, 1962. Contract NAS 5-457. 43p.

An investigation was made of recombination and trapping and of electron spin resonance in normal and irradiated silicon. Four specimens of n-type silicon were studied for their radiation-induced recombination behavior. Three of the four yielded results similar to those reported by a group in the USSR who studied one sample using modulated photo-excitation of excess carriers. The recombination level was located 0.17 ev below the bottom of the conduction band. The fourth n-type sample exhibited behavior similar to that reported by Wertheim, who studied transient recombination in one sample using injection by short bursts of high energy electrons from an accelerator. The principal level was located 0.27 ev above the top of the valence band. Three samples of p-type silicon were also studied. The principal recombination center was a previously unreported level 0.18 ev above the top of the valence band. There is no previous experimental work with which to compare the p-type results. A theoretical treatment of trapping in the presence of direct or indirect recombination was developed and is presented. The results are in good agreement with experiments, which are also described. Three distinct trapping levels were seen, of which two were present before and after electron irradiation, and one located 0.26 ev above the valence band was introduced by the bombardment. ESR spectra were studied in electron and proton irradiated n- and p-type silicon. The spectrum obtained from electron-irradiated phosphorus-doped silicon is shown to arise from the Si–A center previously identified by Watkins and Corbett and found by them in n-type silicon. The proton irradiated n- and p-type silicon gave rise to spectra which were different from the A center and from each other. The spectra are discussed and damage introduction rates estimated for proton and electron irradiation. (auth)

2005 (NP-12193) EFFETTO DELL' IRRAGGIAMENTO SUI COMBUSTIBILI CERAMICI. (Effect of Irradiation on Ceramic Fuels). S. Ferrari and S. Sartori (Italy. Comitato Nazionale per l'Energia Nucleare. Divisione Materiali, Rome). June 1962. 44p. (RT/ING (62)4)

Fission gas release and heat transfer problems related to UO_2 ceramic-type fuel are reviewed. Diffusion and accumulation of the fission gases were taken into consideration. The influence of chemical, physical, and structural characteristics on thermal conductivity was examined. (auth)

2006 (PLASTEC-12) EFFECTS OF THE SPACE ENVIRONMENT ON PLASTICS: A SUMMARY WITH ANNOTATED BIBLIOGRAPHY. Arthur H. Landrock (Picatinny Arsenal. Plastics Technical Evaluation Center, Dover, N. J.). July 1962. 83p.

A brief summary outlines the various space environmental factors, natural and induced, and discusses their effects on plastics and related materials. These factors are: ultraviolet radiation, high-vacuum environment, temperature extremes, high-energy radiation and high-energy particles, sputtering, and micrometeorite erosion. Structural plastics, coatings, and elastomeric materials are considered. The bibliography lists 202 selected references. In the annotations, plastic materials covered in the references are listed and results and conclusions are outlined when feasible. The arrangement is alphabetical by author. An index is provided, covering both materials and subjects. This index is supplemented with additional indexes listing personal and corporate authors, military contract numbers, ASTIA AD numbers, report numbers, and technical conferences. (auth)

2007 (TID-16998) INVESTIGATION OF THE EFFECTS OF IONIZING RADIATION ON THE SEDIMENTATION OF SEWAGE. Quarterly Report, March 1–June 1, 1962. (Unidynamics. Div. of Universal Match Corp., St. Louis). Contract AT(11-1)-905. 63p. (UMC-D62-218)

Improved formulations for simulated sewage were developed during the report period which conform to true

sewage content and sedimentation properties. Specimens conforming to the formulations were used to further evaluate the effects of ionizing radiation on sedimentation. Dose rates of 10.4, 22.6, and 296 rad/min at accumulated dosages ranging from 1200 to 13,300 rad were used. Investigations were also conducted to determine the effects of ionizing radiation on dilute solutions of alkyl benzene sulfonate. Degradation values for this detergent were tentatively established. Data obtained in these investigations are included along with those from an economic evaluation concerning the use of ionizing radiation to increase sedimentation in sewage treatment facilities. (J.R.D.)

2008 (TID-17027) RADIATION EFFECTS IN SOLIDS. Final Report, April 1, 1961–June 31, 1962. J. Ashkin (Carnegie Inst. of Tech., Pittsburgh). Oct. 12, 1962. Contract AT(30-1)-1828. 14p.

Activities in a program to measure changes in lattice parameter, mass density, and distribution of color centers generated by x radiation in alkali halides are reported. Investigation of luminescence in KCl and NaCl crystals revealed that this phenomenon is caused by a radiative transition of electrons which were freed from F centers and subsequently captured at another lattice site. Work on the assymetry of phosphorescence in KCl revealed that three bands exist at liquid N_2 temperature. (J.R.D.)

2009 (TID-17180) EFFECTS OF RADIATION ON GLASS—BIBLIOGRAPHY. M. Comstock and P. Ferrigno (Brookhaven National Lab., Upton, N. Y.). [Oct. 24, 1962]. Contract [AT-30-2-GEN-16]. 41p. (BNL-6513)

References relating to the effects of radiation on glass and other materials are presented. Sources of the references include Ceramic Abstracts, Chemical Abstracts, Nuclear Science Abstracts, Science Abstracts, Series A Physics, and library files. About 500 references are included. (J.R.D.)

2010 (TID-17227) IRRADIATION DAMAGE TO GLASS. Joseph A. Aboaf, J. Raymond Hensler, Norbert J. Kreidl, and Eberhard Leli (Bausch and Lomb Inc., Rochester, N. Y.). Oct. 1962. Contract AT(30-1)-1312. 45p.

Investigation of space charge buildup in irradiated glass including measurement of dielectric properties and d-c conductivity of exposed glasses is reported. Studies of the effect of high pressures on glassy materials have shown the possibility of obtaining compacted forms. (R.J.S.)

2011 (USNRDL-TR-577) EFFECTS OF NUCLEAR RADIATION ON SHIPBOARD ELECTRONIC EQUIPMENT. 1. SOME EFFECTS OF SIMULATED TRANSIT RADIATION ON PARTS. a. TRANSISTORS. H. A. Zagorites, E. A. Carr, and D. Y. Lee (Naval Radiological Defense Lab., San Francisco). Aug. 3, 1962. 250p.

Twenty-six transistor types were irradiated in simulated transit radiation fields in the first phase of a study of nuclear radiation effects on shipboard electronic equipment. The results showed that satisfactory transistor circuit performance is probable where conservative circuit designs can be used. However, it was predicted that some circuits will be susceptible to malfunctions in operationally significant transit fields. Possible effects on equipment reliability are such that they cannot be ignored by the designer. The tests were preceded by an evaluation of the nuclear warfare environment to estimate maximum radiation fields expected on combat effective ships. Fields based on these estimates were simulated with Co^{60} and provided a peak dose rate of about 250,000 r/hr and a dose of 13,100 r. A wide range was observed in the amount of radiation induced effects on β and I_{co}, even within a group of one type of transistor. In general, only temporary changes were observed, with Si types exhibiting smaller effects. For Ge types, I_{co} was observed to change by a factor of 10 to 20 for some types while β changed by a factor of 2 or less, with the change persisting in some types. Analyses failed to show any strong correlations, in general, between radioinduced effects and the preirradiation characteristics of the transistors. The results also indicated that behavior of an individual transistor cannot be predicted satisfactorily from preirradiation measurements. Conservative circuit design and improvement of transistor performance during irradiation appear to be the best approach to the problem of equipment reliability. (auth)

2012 (VDIT-16(2.2)) RADIATION EFFECTS ON SOLID: URANIUM BASED NUCLEAR FUEL MATERIALS. Vol. 2, No. 2, A Bibliography. W. Uhlmann (Aktiebolaget Atomenergi, Stockholm). Sept. 1962. 50p.

Abstracts concerning radiation effects on uranium materials are presented. The materials involved are metallic U, alloys, ceramic U oxides, carbides and dispersion fuels. Abstracts No. 596 to 645 are included. (J.R.D.)

2013 MODEL OF A RADIATIVE INDIUM–GALLIUM LOOP OF THE IRT-2000 REACTOR IN TBILISI. E. L. Andronikashvili, B. G. Buda, G. I. Kiknadze, L. I. Fel'dman, and V. M. Chanturiya. At. Energ. (USSR), 13: 342-9(Oct. 1962). (In Russian)

In previous studies of a liquid In–Ga loop it was shown that it is possible to obtain a γ field equivalent to 10^4 to 10^5 g of Ra in the IRT-2000 reactor. In continuing these studies, the In–Ga alloy was circulated in a closed circuit by means of an electromagnetic pump. The high activation cross section of 145 barn and the short half life of 54 minutes of In^{116} made it possible to reach saturation of its activity within a few hours. A cold trap, similar to that employed for NaK loops, was used for purifying the liquid alloy which contained 24.5 wt % In + 75.5 wt % Ga and had a melting point of (16 ± 0.2)°C. The loop was usually operated at a flow rate of 4.5 cm^3/sec in the main portion and at 3.0 cm^3/sec in the cold trap, at a temperature between 24 and 27°C. After circulating the alloy for 1000 hours, the In concentration was found to be reduced by 2%. One of the purposes of the test was the determination of the corrosion resistance of a 321 type stainless steel. After exposure to an integrated dose of (0.5 to 0.7) × 10^{18} n/cm^2 while the liquid alloy was flowing through it, the stainless steel tubing did not suffer any measurable weight change. The radiative portion of the loop was operated at a power level of 1000 r/min while the specific activity of the alloy was of the order of 2500 mg equiv. of Ra/cm^3. (TTT)

2014 THE INFLUENCE OF CORPUSCULAR BOMBARDMENT ON SOLID-BODY PROPERTIES. E. Schmid (Universität, Vienna). Atompraxis, 8: 321-35(Sept. 1962). (In German)

A concise survey is presented of present theoretical concepts on the question of influencing solid-body properties by corpuscular bombardment. Certain striking examples are taken from the considerable amount of experimental observation material available. (auth)

2015 THE INFLUENCE OF CORPUSCULAR IRRADIATION ON THE PLASTICITY OF METAL CRYSTALS. E. Berninger, S. Ch. Maeng, K. Lintner, and E. Schmid (Universität, Vienna). Atompraxis, 8: 336-9(Sept. 1962). (In German)

An experimental study was made of the influence of alpha, gamma, and neutron rays, as well as beta rays of varying

energy, on the plasticity of zinc crystals. The test results are interpreted. (auth)

2016 RADIATION DAMAGE IN ION EXCHANGERS. K. A. Nater. Atoomenergie Haar Toepassingen, 4: 155-63 (Aug. 1962). (In Dutch)

In nuclear technology and radiochemistry, ion exchangers offer possibilities which are scarcely comparable to other methods. These possibilities, however, are limited by the occurrence of radiation damage. A description is given of the experimental data concerning radiation damage and of the deductions which can be made from the experiments. (tr-auth)

2017 DIELECTRIC DISPERSION IN LITHIUM FLUORIDE CRYSTALS IRRADIATED WITH NEUTRONS. Jacqueline Petiau (Faculté des Sciences, Paris). Compt. Rend., 255: 500-2(July 16, 1962). (In French)

Monocrystalline foils of lithium fluoride irradiated with neutrons at room temperature present, between 10^2 and 10^5 C/sec, two relaxation ranges. The evolution of the dispersion spectrum with temperature between 100 and 500°C shows that the two types of dipolar faults created by irradiation are independent of the presence of divalent cation impurities. One of the two dipolar complexes is probably formed by the association of a lithium ion hole and a fluorine ion hole. On the other hand, the complexes formed by the association of a lithium hole with a divalent cation are transformed and do not give way to the relaxation phenomenon associated with them. (tr-auth)

2018 THE PROBLEMS OF AQUEOUS CORROSION IN THE DOMAIN OF NUCLEAR ENERGY. H. Corious (Commissariat a l'Energie Atomique, Saclay, France). Corrosion Sci., 1: 132-60(Dec. 1961). (In French)

After studying briefly the main forms of aqueous corrosion, the influence of nuclear radiations was investigated as well as the commonly used testing methods. The behavior of different nuclear materials such as uranium, aluminium, zirconium, Zircaloy, stainless steels and nickel alloys was further investigated for their use in water-cooled reactor vessels and in homogeneous reactors. (auth)

2019 BURN-UP AND LIFETIME OF ABSORBER ELEMENTS. B. Koehler (VEB Entwicklung und Projektierung Kerntechnischer Anlagen, Berlin). Kernenergie, 5: 534-41(July 1962). (In German)

A method for the approximate calculation of the neutron physical lifetime of absorber materials with several absorbing nuclides was developed, and the lifetimes of various materials were determined as a function of the layer thickness. A crude economic comparison gives a survey on the favorable introduction range for various materials. (tr-auth)

2020 γ-IRRADIATION OF NATURAL RUBBER LATEX. Mamoru Asao, Kunisawa Shintaro, and Yuji Minoura (Foundation for Natural Rubber Research and Development, Tokyo). Kogyo Kagaku Zasshi, 64: 2066-71(Nov. 1961).

Vulcanized latex was obtained by γ irradiation from a 1-kc Co^{60} source on samples with a viscosity of 52.8 cp, a mechanical stability of 550 sec, a pH of 10.65, and a KOH number of 0.853 at a dosage rate of 1 to 2.5×10^5 r/hr in air. Optimum results were obtained at about 2×10^7 r for 40% latex. Water accelerated the reaction, and rubber in latex cross-linked more easily than previously dried film. Protein in latex deteriorated without damaging the latex properties. The maximum tensile strength of the film obtained by drying the irradiated latex was greater than that of the solid rubber in latex. This corresponded to the fact that irradiation does not bring out side reactions, such as oxidation, of rubber in latex even in air. The aging property of the film was superior, and the tensile strength of the film after aging was even greater than before. The effect of the organic halogen on cross-linking indicated that the compounds accelerated cross-linking and lowered the optimum dosage without appreciable side reactions. (OID)

2021 THE LINE AND BAND SPECTRA OF RADIATION-COLORED LITHIUM FLUORIDE. W. von der Osten and W. Waidelich (Technische Hochschule, Munich). Naturwissenschaften, 49: 342-3(1962). (In German)

The line and band spectra of LiF are produced by irradiation with x-rays, electrons, neutrons, and α particles. The effect of the various radiations on the half-value width of the strongest line are shown. The line spectrum is altered by heat treatment of the crystal after irradiation. Measurements made at 20 and 90°K show that at 90°K lines are visible only from strongly irradiated crystals. New line groups found are tabulated. (J.S.R.)

2022 FISSION GAS RELEASE AND SWELLING DURING HEATING OF IRRADIATED EBR-II TYPE FUEL. N. R. Chellew and R. K. Steunenberg (Argonne National Lab., Ill.). Nuclear Sci. and Eng., 14: 1-7(Sept. 1962).

Swelling and rare gas release of irradiated prototype EBR-II fuel pins during heating were studied with material containing 320 to 830 ppm of these gases (0.2 to 0.6 at. % burnup). Data on both phenomena were obtained at varied heating rates and with stepwise heating to successively higher temperature levels. In each experiment, over 99% of the rare gases was released before the alloy was fully molten at about 1080°C. Within experimental error the behaviors of Xe-133 and Kr-85 were identical. Below 750°C, gas release was slow; above 750°C, the rate increased sharply. The quantity of gas evolved as a function of time at constant temperatures to 850°C appeared to be directly proportional to the time rather than the square root of time as predicted by diffusion theory. Swelling of the alloy showed much the same type of temperature dependence as the release of rare gas. For all heating patterns, pin swelling was most pronounced above 750°C, reaching a maximum diametral increase of about 47% as the pin melted. A brief comparison between the release of rare gas from this alloy and that from other metallic fuels is made. The effects of this phenomenon and associated swelling on the melt refining process envisioned for recovery of fuel from the first core loading of EBR-II are discussed. (auth)

2023 IRRADIATION TESTING OF FUEL MATERIALS FOR EGCR. D. B. Trauger (Oak Ridge National Lab., Tenn.). Nuclear Sci. and Eng., 14: 69-82(Sept. 1962).

Irradiation tests were conducted in the ORR, ETR, and LITR for evaluating fuel materials for the EGCR. Time limitations imposed by the reactor construction schedule restricted material choices and test conditions to those immediately appropriate for the EGCR and necessitated some replication. Fifty-nine assemblies were irradiated at stainless steel cladding surface temperatures of 1300 to 1600°F and power densities both above and below 30,000 Btu/hr per foot of UO_2 fuel length. NaK-filled containers were employed to test prototype-size fuel capsules, and air-cooled capsules of reduced size were used for fission-gas-release studies. External pressurization of 315 psia was applied to fuel assemblies of prototype size. Preliminary results appear to affirm the adequacy of the fuel element design. (auth)

2024 IRRADIATION EFFECTS IN THE EGCR FUEL. J. G. Morgan, M. F. Osborne, and O. Sisman (Oak Ridge National Lab., Tenn.). Nuclear Sci. and Eng., 14: 83-100 (Sept. 1962).

Post-irradiation examinations were completed on all but the very long burnup samples for the EGCR fuel evaluation

studies. The results confirmed the reliability of this fuel element design at least up to the burnup thus far attained (2400 Mw-day/metric ton UO_2). Fission gas release was not excessive except for the very high temperature irradiations. Although the pellets did sometimes show considerable cracking, pieces did not fall into the central cavity, and the hollow cylinder pellet design was shown to be stable. In the 1600°F prototype experiments, ridges were formed in the clad at pellet interfaces and evidence of sigma phase formation and some void formation was found in the metallographic examination of the ridges. The CO_2 was found to contain many fine cracks which caused the pellets to break up on handling, but very little fuel shifting occurred before the cans were cut open. (auth)

2025 A POSSIBLE MECHANISM OF IRRADIATION CREEP AND ITS REFERENCE TO URANIUM. R. V Hesketh (Berkeley Nuclear Labs., Gloucester, Eng.). Phil. Mag. (8), 7: 1417-20(Aug. 1962).

The Anderson-Bishop-Cottrell mechanism of irradiation creep in alpha uranium does not explain some of the experimental results, e.g., recovery of creep strain after irradiation. A second mechanism effective at high temperatures is derived which involves the reversion of loop nuclei to clusters when the thermal spikes disappear (thermal annealing of creep). (D.L.C.)

2026 THE EFFECTS OF NEUTRON IRRADIATION ON SOME MECHANICAL PROPERTIES OF DIAMOND. Eileen M. Wilks (Clarendon Lab., Oxford). Phil. Mag. (8), 7: 1421-3(Aug. 1962).

An investigation was made on the effects of neutron irradiation on the abrasion hardness and cleavage properties of diamond. Irradiation reduced the hardness by factors between 1.2 and 2.0, and the cleaved surfaces in irradiated diamonds were very different from the usual cleaved surfaces. (D.L.C.)

2027 THE RELATIVE IMPORTANCE OF GRAIN BOUNDARIES AND SUB-GRAIN BOUNDARIES IN THE IRRADIATION HARDENING OF MOLYBDENUM. A. S. Wronski and A. A. Johnson (Imperial Coll. of Science and Tech., London). Phil. Mag. (8), 7: 1429-31(Aug. 1962).

Molybdenum specimens with differing grain sizes but similar sub-grain sizes were irradiated to an epithermal neutron dose of $\sim 2 \times 10^{18}$ nvt and their yield stress measured. The plot of the data versus $(2d)^{-\frac{1}{2}}$, where d is the grain diameter, shows that the yield stress is not independent of grain size; hence, the hypothesis of sub-boundaries being strengthened by irradiation is not correct. It is noted that the irradiation hardening is approximately the same as that observed previously for a dose ten times as large. (D.L.C.)

2028 THE EFFECTS OF IRRADIATION ON METALS. Frederick Seitz (Univ. of Illinois, Urbana). Science, 138: 563-71(Nov. 2, 1962).

Applications of electrons with energies in the neighborhood of 1 Mev, changed nucleons such as protons or deuterons, and neutrons in the bombardment of metals to provide information concerning interstitial atoms and vacant sites are discussed. Emphasis is placed on the close-packed noble metals, of which Cu, Ag, and Au are the prototypes. A technique is described for use in the estimation of the effectiveness of incident radiations in producing displacements of atoms from normal lattice positions. Typical displacement calculations for Cu are presented that were obtained from the simple square-well theory for three typical bombardments. Topics discussed include thermally induced defects in lattice structure, a comparison of lattice and microscopic expansion in metals, the quenching-in of vacancies, and experimental aspects of radiation bombardment. (C.H.)

2029 DIELECTRIC CONSTANT AND REFRACTIVE INDICES OF QUARTZ AFTER EXPOSURE TO FAST NEUTRONS. V. G. Zubov and A. P. Grishina (Moscow State Univ.). Soviet Phys.-Cryst. (English Transl.), 7: 185-7 (Sept.-Oct. 1962).

Measurements of the dielectric constant and refractive indices were carried out on single quartz crystals irradiated with integral doses of 2×10^{19} n/cm^2. The changes were –1.5% and –0.7% for dielectric constant normal to and along the optic axis, respectively, and –0.03% for ordinary ray refractive index and –0.05% for extraordinary ray refractive index. The refractive index changes agree well with these estimated from the density changes, while the dielectric constant changes do not. It is concluded that the dielectric constant may give an indication of any change in the type of defects with dose. (D.L.C.)

2030 VARIATION IN DISLOCATION DENSITY, RATE OF CONTACT MELTING AND RATE OF DISSOLUTION OF CRYSTALS EXPOSED TO RADIATION. I. G. Berzina and I. B. Berman (Tomsk Polytechnic Inst., USSR). Soviet Phys.-Cryst. (English Transl.), 7: 261-3(Sept.-Oct. 1962).

The effects of neutron irradiation on the rate of contact melting were studied for a large number of pairs of metallic crystals, while the effects on the rate of dissolution were studied for NaCl crystals in water. In both cases, the rate was greatly increased immediately after irradiation, but it decreased with time to a constant value less than that of unirradiated crystals. Similar results were obtained for the dislocation density in irradiated KCl crystals. It is concluded that the observed contact melting and dissolution phenomena are due to an intense movement of the radioinduced defects in the relaxation process following irradiation, resulting in partial annihilation and a reduction in the dislocation density. (D.L.C.)

2031 EFFECT OF X-RAY IRRADIATION ON THE STRUCTURE OF CRYSTALS OF NaCl TYPE. E. V. Kolontsova and A. Kulyavik (Moscow State Univ.). Soviet Phys.-Cryst. (English Transl.), 7: 281-5(Nov.-Dec. 1962).

Using the methods of anomalous scattering and selective etching, an investigation was made of the defects occurring in single crystals of NaCl, KCl, and LiF exposed to x radiation. The changes in structure were qualitatively analogous to the changes in structure appearing in crystals exposed to neutron radiation. Point-type defects were produced, distributed in a statistically random manner in the body of the crystal. The surface of the irradiated crystals showed cavities of rectangular form, bounded by [100] faces, and evidently formed by accumulations of vacancies. Two-dimensional disturbances oriented along the [100] and possibly [130] planes appeared in the irradiated crystals. (P.C.H.)

2032 THE COEFFICIENT OF LINEAR EXPANSION OF KCl CRYSTALS IRRADIATED BY PROTONS. I. N. Anokhina, I. G. Berzina, I. B. Berman, and L. S. Sokolov (Kirov Tomsk Polytechnical Inst., USSR). Soviet Phys.-Cryst. (English Transl.), 7: 338-40(Nov.-Dec. 1962).

Using KCl crystals, the dependence of the coefficient of linear expansion and density of dislocations on the dose of radiation of protons with an energy of 4.5 Mev was studied. It was shown that the change in the coefficient of linear expansion corresponds to the change in density of the dislocations. The dependence of the coefficient of linear expansion, measured at various temperatures, on the radiation dose, is given. (auth)

2033 INTERACTION OF LITHIUM ATOMS, INTRODUCED INTO SILICON, WITH RADIATION DEFECTS OF THE STRUCTURE. V. S. Vavilov, I. V. Smirnova, and V. A. Chapnin (Lomonosov Moscow State Univ.). Soviet Phys.-Solid State (English Transl.), 4: 830-2(Nov. 1962).

It is shown that in lithium-doped silicon single crystals the lithium ions interact with structural defects produced by fast-electron bombardment. (auth)

2034 ENERGY SPECTRUM OF DEFECTS PRODUCED IN SILICON BY IRRADIATION WITH ELECTRONS. N. A. Vitovskii, D. P. Lukirskii, T. V. Mashovets, and V. I. Myakota (Ioffe Physico-Technical Inst., Academy of Sciences, Leningrad). Soviet Phys.-Solid State (English Transl.), 4: 840-4(Nov. 1962).

The temperature dependence of the Hall coefficient was studied in n- and p-type silicon irradiated with electrons of ≈2 Mev energy. In the range of energies limited by the levels of chemical donors and acceptors, four levels of radiation defects were found: two lay in the upper half of the forbidden band, and the other two in the lower half. These levels were generated at various densities. The activation energies of the levels and the rates of their formation were determined. (auth)

2035 CONCERNING THE RADIATION DEFECT SPECTRUM IN SILICON. W. M. Malovetskaya, G. N. Galkin, and V. S. Vavilov (Lebedev Physical Inst., Academy of Sciences, Moscow). Soviet Phys.-Solid State (English Transl.), 4: 1008-9(Nov. 1962).

The irradiation of p-type Si single crystals containing 10^{15} to 10^{18} oxygen atoms/cm^3 by 1-Mev electrons is observed. Energy levels are found to be produced at 0.21 and 0.27 ev above the valence band level. The annealing properties of the 0.21-ev level are studied at 17 to 80°C. It is inferred that the 0.27-ev level is caused by the interaction of dissolved oxygen atoms with interstitials. (T.F.H.)

2036 PROPERTIES OF IRRADIATED POLYETHYLENE. H. Kakimoto and M. Watanabe (Sumitomo Electric Industry, Ltd., Osaka). Sumitomo Denki, No. 75, 35-47 (Mar. 1961).

The types of radiation sources, dosages, initial reaction mechanism, and effects on high polymers are summarized. The effects on irradiated polyethylene (below 10^6 rad) were reviewed with respect to reaction scheme, the generation of gases, the formation of unsaturated bonds, the relationship between cross-linking and galation rate, molecular weight, crystallinity variation, mechanical strength, thermal deformability, oxidation resistancy, electrical properties, and chemical resistivity. The results showed that the irradiated polyethylene could be used as a material for electric wires and films. (OID)

2037 ANALYSIS OF ENGINEERING AND BASIC RESEARCH ASPECTS OF NEUTRON EMBRITTLEMENT OF STEELS. W. S. Pellini, L. E. Steele, and J. R. Hawthorne (Naval Research Lab., Washington, D. C.). Welding J., (N. Y.), 41: 455s-69s(Oct. 1962).

A summary is given of (a) the present status of fracture-safe engineering design for steel structures, with emphasis on the role of the nil ductility transition temperature in brittle fracture analysis, (b) the present state of knowledge regarding irradiation embrittlement of steels and recovery treatments, with emphasis on the need for basic knowledge of mechanisms because of the complexities and tediousness of direct experimentation, (c) the limitations to the exact definition of neutron environment conditions, and (d) research requirements made evident by the three preceding topics, such as the requirements for improved dosimetry. (auth)

2038 2 MEV ELECTRON IRRADIATION AND THERMAL ANNEALING OF PURE COPPER AT LOW TEMPERATURE. Robert Lee Chaplin, Jr. Thesis, Raleigh, North Carolina State Coll., 1962. 99p.

Radiation damage studies of pure copper specimens were performed by using a Van de Graaff accelerator to supply energetic electrons of 2 Mev. The irradiating electrons were magnetically deflected so that the electron beam bombarded a well-defined rectangular area. A method was also developed for determining the location of the electron beam with respect to specimen position. A 25-liter liquid helium cryostat maintained the necessary low temperature. In order to control the annealing temperature, a thermal switch was used which governed heat transfer according to the admission or evacuation of helium exchange gas. The theoretical aspects and experimental behavior of all cryogenic equipment are discussed. One major problem of low-temperature irradiation of metal samples concerns the thermal conduction between specimen and specimen holder. It was found that it is practical to use the helium exchange gas technique for improving this thermal contact. Estimates of the degree of thermal contact between the specimen and its holder were also possible because of the particular electrical circuit which was used in the experimental chamber. Resistance measurements were obtained by the potentiometric method. Reliable potential readings were obtained to approximately 10^{-8} volts for the high purity copper samples which were irradiated. The recovery data pertaining to the relative change of resistivity due to annealing make use of a procedure which reduced systematic experimental errors. Results of this work are in the region where multiple defect production occurs during irradiation. The number of multiple defects produced during 2 Mev electron irradiation was obtained from existing theories. This enabled an experimental evaluation of the magnitude of resistivity change per atomic percent of Frenkel defects. Good agreement is obtained by this technique of evaluation when results are compared to previous experimental determinations. Thus, the simple theory of atomic displacements suffices for explaining results of this work. The low-temperature substages of high purity copper, which are associated with the recovery of Frenkel defects, were measured following each 2-Mev electron irradiation. The initial four substages of stage I recovery were evident from this work. The results associated with close pair Frenkel defect recovery show that a correlation exists between prior experimental work performed by lower energy electron and 10-Mev deuteron bombardments. It is evident that each intrinsic substage possesses a very definite dependence upon irradiation energy. (Dissertation Abstr., 23: No. 3, 1962)

2039 TRANSIENT RADIATION EFFECTS IN COAXIAL CABLES DUE TO GAMMA-NEUTRON RADIATION PULSES. H. W. Wicklein (Boeing Co., Seattle). Preprint Paper No. 62-1079. New York, American Institute of Electrical Engineers, 1962. 23p. $1.00.

Definitive good-geometry tests are performed on coaxial cables, using a pulsed reactor. The radiation-induced current from center conductor to grounded shield is described analytically, as a function of voltage, radiation pulse amplitude, and pulse shape. Mechanisms responsible for the current are Compton scattering, ion-pair generation, and secondary emission. (auth)

2040 MECHANISMS OF TRANSIENT RADIATION EFFECTS IN ELECTRONIC PARTS. V. A. J. van Lint (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Preprint Paper No. CP 62-1078. New York, American Institute of Electrical Engineers, 1962. 5p. $1.00.

The mechanism whereby intense ionizing radiation produces transient radiation effects in electronic parts is analyzed. Important manifestations include: generation of excess carriers in semiconductors, causing enhanced reverse leakage currents in junctions; emission of secondary electrons from surfaces; enhanced conductivity in gases and insulators; and optical effects, such as absorption and fluorescence. Some of these effects can be estimated by order-of-magnitude calculations, and the results used to interpret transient effects in electronic circuits. (auth)

2041 RADIATION EFFECTS IN FERROELECTRIC MATERIALS. L. G. Wright, C. A. Rosen, and S. I. Taimuty (Stanford Research Inst., Menlo Park, Calif.). Preprint Paper No. 62-1077. New York, American Institute of Electrical Engineers, 1962. 11p. $1.00.

The effects of reactor radiation (10^{15} to 10^{18} neutrons/cm^2) on the dielectric properties of $BaTiO_3$, 96% $BaTiO_3$ + 4% $PbTiO_3$, 95% $BaTiO_3$ + 5% $CaTiO_3$, and lead zirconate–lead titanate were studied. Complex permittivity and large-signal hysteresis properties were measured before and after irradiation, after room temperature aging, and after 500°C heat treatment. Effects on the hysteresis properties and the small-signal permittivity were small except for exposures of 10^{18} n/cm^2. All of the measured properties were affected in some degree by aging and heat treatment. (auth)

2042 THE EFFECTS OF RADIATION ON FERRITES. S. I. Taimuty and J. S. Mills (Stanford Research Inst., Menlo Park, Calif.). Preprint Paper No. CP 62-1076. New York, American Institute of Electrical Engineers, 1962. 9p. $1.00.

The effects of reactor exposures (10^{16} to 10^{18} fast neutrons/cm^2) on the magnetic properties of 16 polycrystalline ferrites and garnets are presented. Measured properties include coercive force, remanence, saturation induction, complex permeability, and ferromagnetic resonance (FMR) linewidth. It is found that the hysteresis properties and FMR linewidth are slightly affected by exposures of 10^{18} neutrons/cm^2. Complex permeability is affected by exposures as small as 10^{16} neutrons/cm^2. All of the observed changes are small. (auth)

2043 ANALOG COMPUTER TECHNIQUES FOR THE PREDICTION OF TRANSIENT NUCLEAR RADIATION EFFECTS ON TRANSISTOR CIRCUITS. Lembit Kosenkranius (Boeing Co., Seattle). Preprint Paper No. CP 62-1082. New York, American Institute of Electrical Engineers, 1962. 18p. $1.00.

The representation of transistor circuits with an analog computer was developed for predicting transient responses of these circuits during nuclear radiation bursts. Transistors were simulated from the measured or manufacturer-specified characteristic curves. Radiation effects in the transistors were added in the form of transient increase in emitter-to-base potential, and by the reduction of current gain of the transistor with a radiation-controlled negative feedback. Linear networks between transistors were simulated from the transfer functions of these networks. A comparison was made between the responses of real and simulated single-stage common-emitter amplifiers, under real and simulated radiation bursts, respectively. (auth)

2044 GAMMA-RAY-INDUCED COLORING OF GLASSES IN RELATION TO THEIR STRUCTURE. Adli M. Bishay (American Univ., Cairo) and K. R. Ferguson. p.133-48 of "Advances in Glass Technology." New York, Plenum Press, Inc., 1962. (TID-15294)

Optical absorption induced by ionizing radiation in glasses of different compositions was resolved into Gaussian-shaped bands in the range 1 to 6 ev. The differences in the position and intensity of the bands in silicate, borate, phosphate, and germanate glasses is partly ascribed to the difference in their structure. The induced absorption was the result of an equilibrium between the formation and annihilation of color centers. The equilibrium was influenced by the polarizing power and the coordination number of network-forming and -modifying ions, the concentration of nonbridging oxygen ions, and the presence of multivalent network-forming or -modifying ions. The direction in which the equilibrium shifted depended on the glass structure and type of color center. It was also observed that melting under reducing conditions decreased the intensity of the visible bands and increased the intensity of the ultraviolet bands as compared to melting under normal conditions. Borate glasses show a unique relationship between the induced absorption and changes in the structure, such as concentration of BO_4 units and nonbridging oxygen ions. (auth)

2045 THE TRANSIENT BEHAVIOR OF TRANSISTORS DUE TO IONIZING RADIATION PULSES. R. S. Caldwell (Boeing Co., Seattle), D. S. Gage, and G. H. Hanson. Preprint Paper No. 62-1081. New York, American Institute of Electrical Engineers, 1962. 19p. $1.00.

The detailed mechanism of secondary photocurrent generation in transistors, resulting from short pulses of ionizing radiation, is discussed quantitatively. The results of 0.2-μsec flash x-ray experiments are explained. The dependences of the transient current pulse on transistor types, radiation dose, initial bias level, and external circuit impedance are presented. A possible equivalent circuit controlled by stored base charges is developed, which makes possible the accurate prediction of the transient responses of many transistor circuits. (auth)

2046 METHOD OF CURING POLYMERS. Roland William Pearson (to Dunlop Rubber Co. Ltd.). British Patent 909,061. Oct. 24, 1962.

A method for curing polymers by means of radioinduced crosslinking is given which requires less radiation than other methods. The method comprises subjecting the polymer to ionizing radiation while in the solid state and in the presence of a "promoter" having the formula $CH_2 = CHCH_2OOCNHRNHCOOCH_2CH = CH_2$. The irradiation preferably is carried out in vacuum or an inert gas above the room temperature and is most effective on unsaturated polymers, whether natural or synthetic. Several examples of the method are given in which rubber and polyethylene are treated with 1,5-naphthalene diallyl diurethane before gamma irradiation. (D.L.C.)

2047 RADIATION CURING OF POLYMERS. Herbert R. Anderson, Jr. (to Phillips Petroleum Co.). U. S. Patent 3,057,791. Oct. 9, 1962.

A method is given for vulcanizing rubber without a curative agent. The method comprises incorporating a lithium compound into the rubber and then irradiating it with thermal neutrons. The amount of lithium compound added should be 0.05 to 0.5 gram moles of lithium per 100 grams of polymer. (D.L.C.)

2048 RUBBER PRODUCTS RESISTANT TO RADIATION DAMAGE. Herbert R. Anderson, Jr. (to Phillips Petroleum Co.). U. S. Patent 3,057,818. Oct. 9, 1962.

A method is outlined for improving the radiation resistance of rubber products. The method comprises adding 2 to 10% of an inhibitor comprising a diaryl-substituted acetylene or a polyaryl-substituted ethylene. (D.L.C.)

PHYSICS

General and Miscellaneous

Refer also to abstract 1945.

2049 (AD-274740) STATISTICAL MECHANICAL THEORY OF MAGNETIC RESONANCE (thesis). Technical Report No. 261. P. L. Kelley (Massachusetts Inst. of Tech., Lexington. Lincoln Lab.). May 1, 1962. Contract [AF19(604)-7400]. 41p.

The quantum statistical theory of magnetic resonance considered is that of independent spins in the presence of external static and oscillating fields and a heat bath. An equation of motion is found for only that part of the density operator necessary to calculate properties of the spin system resulting in a linear inhomogeneous integrodifferential equation. The kernel of the integral term, expressed as a power series in the pin-bath interaction, is cut off to a certain order by a Born-like approximation. The memory approximation is also made. Averaging the resulting equation over the bath gives a differential equation for the spin density operator. Conditions for the validity of the series cutoff and the memory approximation were found. The first is tested by comparing one order in the series with the next higher-order term and the second approximation is tested by solving the integrodifferential equation by the transform method. Bloch's equation is found to agree with the present equation cut off to second order and memory approximated, except for inhomogeneous terms which arise in the present theory from initial conditions. For the case in which the density operator is linearized in the external oscillating field, terms are obtained which represent interference between the external oscillating field and the spin-bath interaction and which were neglected by Wangsness and Bloch. The linearized steady-state solution containing these additional terms was found for spin $\frac{1}{2}$. (auth)

2050 (ARF-1209-6) STUDY OF THE CAPABILITY OF ISOTOPIC SOURCE OF SECONDARY RADIATION. Quarterly Report No. 2, June 1, 1962 to August 31, 1962. James J. Ezop (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Sept. 10, 1962. Contract AT(11-1)-578. 12p.

Activities are reported in a program to determine optimum beta-excited x-ray source designs which, when used with image intensifier techniques and x-ray film systems, are of practical use in dental radiography, airframe inspection, and in other nondestructive testing. Work during the period was devoted to rate measurements on a Pm^{147} source and to trial x-ray exposures. Plans for future work are outlined. (J.R.D.)

2051 (CU(PNPL)-219) PROGRESS REPORT [ON NUCLEAR PHYSICS] FOR APRIL–JUNE 1962. (Columbia Univ., New York. Pegram Nuclear Physics Labs.). Contract AT(30-1)-Gen-72. 53p.

Work in neutron physics research was devoted to development of a neutron velocity spectrometer, aspects of fission in U^{235} and Pu^{239}, neutron reactions (n,p) at 3.2 Mev, development of a He^3 spectrometer, elastic scattering of neutrons by O, neutron polarization in the reaction $B^{11}(d,n\gamma)C^{12}$ and U^{235} half-life measurements. Charged particle investigations were concerned with evaluation of the duoplasmatron source, development of a pyrex leak for He, angular distributions in $Mg^{25}(d,p)$ reactions at 3 to 5 Mev, and hyperfine structure of O^{15}. Light particle investigations were conducted to measure the lifetime of the second excited state in Ni^{60} and Ti^{46}. Other work is reported on measurement of the β^- branching ratio of 3.7 hr Lu^{176}. Theoretical investigations were conducted to determine the structure of low-lying 2^+ states in even-even nuclei and beta-gamma angular correlations. Development is reported on semiconductor detection devices, amplifiers, current regulators, pulse analyzers, time delay generators, oscillators, and an automatic turntable code translating unit. (J.R.D.)

2052 (JINR-P-1017) O RAZLICHNYKH PARAMETRIZATSIYAKH V TEORII KVANTOVANNOGO PROSTRANSTVA-VREMENI. (On Various Parameterizations in the Space Time Quantum Theory). V. G. Kadyshevskii (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 7p.

Problems related to the non-singularity in the determination of the Snyder's 4-pulse vector theory are analyzed as a continuation of V. G. Kadyshevskii (J. Exp i Teoret Fiz., 41: 1885, 1961) work. An attempt was made to find relativistically co-variant hyperspheres with geodesic stereographic, and orthogonal projection parameterization. (R.V.J.)

2053 (JINR-P-1028) RELYATIVISTSKII GAZ V GRAVITATSIONNOM POLE. (Relativistic Gas in Gravitational Field). N. A. Chernikov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 23p.

The Boltzmann kinetic equation is established for the rarefied relativistic gas in the gravitational field with smallest restrictions on the topological structure of the space–time manifold. The equation of change of molecular properties is obtained. It is proved that the divergences of the numerical flux vector and the energy–momentum tensor vanish. It is also proved that the divergence of the flux vector of the entropy is nonnegative (H–theorem). The principle of the detailed balancing for the relativistic gas in the equilibrium state is considered. (auth)

2054 (KR-28) POSITRONIUM FORMATION AND DYNAMICS IN ALUMINUM OXIDE. Joergen Loevseth (Norway. Institutt for Atomenergi, Kjeller). Aug. 1962. 21p.

An automatic apparatus based on a 4 × 4 coincidence unit for measuring the angular correlation of the annihilation radiation is described. The positronium formation is found to depend strongly on the crystallinity of the material and on the gas adsorbed on the surface. Thus NO_2 reduces the narrow component; H_2, N_2, and Ar show no difference when compared with vacuum, whereas O_2 by a conversion process increases the narrow component by 150% at atmospheric pressure. Singlet positronium initially formed in the singlet state is slowed down to 0.5 ev and that formed by conversion to 0.1 ev. A method of data treatment by use of an electronic computer is described. (auth)

2055 (LADC-5449(Rev.)) ON THE STRUCTURE OF A DETONATION WAVE IN THE LIMIT OF VANISHING PRANDTL AND LEWIS NUMBERS. W. W. Wood (Los Alamos Scientific Lab., N. Mex.). [1961]. Contract [W-7405-eng-36]. 6p.

Steady detonation solutions of the Navier-Stokes equations were investigated in the case of arbitrary Prandtl number (Pr) and zero Lewis number (Le), also for Pr =

$^3/_4$, Le = 1. A discussion is presented to indicate that the behavior found in these investigations is also likely to appear in the inviscid limit Pr → O. (J.R.D.)

2056 (LADC-5459) PROPOSED NOMENCLATURES FOR THE HELIUM ALLOTROPES. A. F. Schuch and R. L. Mills (Los Alamos Scientific Lab., N. Mex.). Sept. 1962. Contract [W-7405-eng-36]. 7p.

A discussion of He allotropes is presented in which it is noted that designations such as He I, He II, He^3, and He^4 are already in use. It is proposed that the allotropes of this element be named by the letters alpha, beta, and gamma. Using this system, the body-centered cubic phase is called alpha, the hexagonal close-packed phase beta, and the cubic close-packed phase gamma. (J.R.D.)

2057 (NP-12190) PHYSICS OF HYDROGEN RADIATION. Claire Chapin, Jr. (Purdue Univ., Lafayette, Inc. School of Aeronautical and Engineering Sciences). Sept. 1962. 87p.

As a step to understanding the radiation from gases which are made up of complex molecules it was considered advantageous to study the simplest case, atomic hydrogen. An attempt was made to gather together the various facts and theories about atomic hydrogen radiation as they relate to the physical process which causes various radiation phenomena in atomic hydrogen. (auth)

2058 (NP-12207) PROGRESS REPORT NO. 8 [ON WAVE MECHANICS], SESSION 1961–1962. (Oxford Univ. Mathematical Inst.). 81p.

Forty-one articles dealing with wave mechanics are presented. The information deals with scattering, electronic structure of atoms and molecules, and electronic problems associated with solids. (N.W.R.)

2059 (ORNL-TM-305) OR FLS—A FORTRAN CRYSTALLOGRAPHIC LEAST-SQUARES PROGRAM. W. R. Busing, K. O. Martin, and H. A. Levy (Oak Ridge National Lab., Tenn.). Aug. 1962. Contract W-7405-eng-26. 77p.

A computer program to perform the least-squares refinement of crystal structure parameters based on x-ray- or neutron-diffraction measurements is described. The program is written mostly in the Fortran language to facilitate modification and to permit its use on various machines. Detailed instructions for its use are included, and the required card decks may be obtained. (auth)

2060 (TID-14168) SOME FUNDAMENTAL ASPECTS OF VAPORIZATION: VAPORIZATION COEFFICIENTS. R. J. Ackermann, R. J. Thorn, and G. H. Winslow (Argonne National Lab., Ill.). Aug. 1961. Contract [W-31-109-eng-38]. 44p. (UAC-5596)

Methods for the consideration of the problems of vaporization and condensation are reviewed. In particular, the methods of irreversible thermodynamics have been shown to be conducive to the generation of explanations that can be subjected to experimental test. (auth)

2061 (TID-16592) SORPTION OF GASES ON METAL SURFACES IN ULTRAHIGH VACUUM. Quarterly Progress Report No. 2, May 15, to August 15, 1962. R. A. Pasternak and Bjoern Bergsnov-Hansen (Stanford Research Inst., Menlo Park, Calif.). Sept. 6, 1962. Contract AT(04-3)-425. 14p.

A program to study the reactions of gases with clean metal films is reported. Major efforts during the period were devoted to construction and testing components of an ultrahigh vacuum system for use in the study. Completion and preliminary testing of a bakeable mass spectrometer is also reported. Discussion is included on pumping system development, electron beam evaporator operation, and design of the spectrometer. (J.R.D.)

2062 (TID-17185) BORN REPULSIVE POTENTIAL IN THE ALKALI HALIDE CRYSTALS. Fausto G. Fumi (Argonne National Lab., Ill. and Northwestern Univ., Evanston, Ill.). Aug. 1962. Contract W-31-109-eng-38. 14p. (UAC-6811)

Attempts are described to improve the current knowledge of the Born repulsive potential in the alkali halides in view of its critical role in the study of point imperfections by the Born model. The validity of various approximations to the equation of state of cubic solids, used in this connection, is clarified. Some evidence in favor of the Born-Mayer form of the Born repulsive potential is derived from the dependence of the experimental Born repulsive energy on interionic distance, as determined from a detailed analysis of high-pressure compression data. Some confirmation of the heuristic assumptions involved in the Huggins-Mayer procedure for the determination of the Born-Mayer repulsive parameters is obtained from the agreement between the crystal radii for the alkali and halogen ions in the individual alkali halides, derived from these repulsive parameters, and the experimental crystal radii, derived from the x-ray maps for the electron distribution in the solid. Finally, some insight into the many-body contributions to the Born repulsive energy is gained from a Born-model study of the polymorphic transitions of the alkali halides. (auth)

2063 (UCRL-5947-T) THE ATOMIC PHOTOELECTRIC EFFECT AT HIGH ENERGIES. Harvey Hall (California. Univ., Livermore. Lawrence Radiation Lab.). Apr. 1960. Contract W-7405-eng-48. 6p.

The theory of the high-energy photoelectric effect is discussed. It was found by several workers that the equation for photoelectric absorption of hard gamma rays by the two K electrons of an atom, $\tau_K \cong \tau_{K^0}/a^{2a^2} e^{\pi a - 2a^2}$, is too large for heavy elements. A formula proposed by Pratt reduced the equation by the factor $1 - {}^4/_{15}\,\pi a$, where a = Z/137. Other derivations of this formula are discussed. (M.C.G.)

2064 (FTD-TT-62-65) MASS AND ENERGY TRANSFER. P. K. Konakov. Translation of a Paper for Presentation at the Heat Transfer Conference, June 5-10, 1961, Minsk, USSR. 10p. (AD-271836)

A continuous medium in the region of space V_0 undergoing motion that is nonsteady-state with time was considered for mass and energy transfer. Laws were formulated to establish a connection between the mass-transfer and energy-transfer vectors. The process of mass transfer between two uniform bodies having different mass densities was examined. The process of energy transfer between these two bodies was also studied. It was found that the concepts of mass and energy transfer between two uniform bodies with different mass and energy densities can be applied to the corresponding process of transport associated with particles of the bodies. (M.C.G.)

2065 (JPRS-15517) NEWS OF HIGHER EDUCATIONAL INSTITUTIONS, MINISTRY OF HIGHER AND SECONDARY SPECIALIZED EDUCATION USSR, RADIOPHYSICS SERIES. Translation of Izvestiya Vysshikh Uchebnykh Zavedenii, Radiofizika, 5: No. 2, 211-415(1962). 473p.

Twenty-eight papers on radiophysics are included in this cover-to-cover translation. Separate abstracts were prepared for two papers. (M.C.G.)

2066 (JPRS-15517(p.65-77)) PROPAGATION OF ELECTROMAGNETIC DISTURBANCES ALONG A MAG-

NETIC FIELD IN A DILUTE PLASMA. V. V. Arsenin. Translated from Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 5: 240-5(1962).

The attenuation of initial electromagnetic disturbances propagating in a rarefied plasma along an external magnetic field was considered. The action of the wave magnetic field was not taken into account. The problem of motion reversibility in time is discussed. (auth)

2067 (JPRS-15517(p.423-30)) DEVIATIONS FROM STRUCTURAL REGULARITY OF MAGNETIC FIELD IN THE OUTER SOLAR CORONA. V. V. Vitkevich. Translated from Izv. Vysshikh Uchebn. Zavedenii, Radiofiz., 5: 402-3(1962).

Previous studies of the direction of the magnetic field in the outer solar corona yielded a discrepancy in observations. Part of the results indicated a radial magnetic field and others indicated that the direction of the magnetic field differed greatly from radial. Two possible explanations for the difference in observations are given. One is that the results are due to different directions of sighting through the supercorona. It is also possible that the presence of an elongated plasma formation produces refraction of the radio waves. (M.C.G.)

2068 (SCL-T-441) DEPENDENCE OF THE PHOTOELECTRIC CURRENT ON THE CONCENTRATION OF F-CENTERS IN THE CASE OF THE X-RAYED NaCl CRYSTALS. Emery Tarjan, Rudolf Voszka, and Agnes Somlo. Translated by Erik Arnhem (Sandia Corp., Albuquerque, N. Mex.) from Magy. Fiz. Folyoirat, 8: 21-30(1960). 14p.

The multiplication product of the degree of the quantum effect and of the path of deviation regarding the space power of the unit ($\eta\omega$) in natural and artificial NaCl crystals x-rayed at room temperature is discussed, as well as the concentrations of F centers. The connection $\eta\omega = 1 (A + BN_F)$, where N_F is F-center concentration and A and B are constants concerning the same crystals, can be described by means of algebraic functions using results of these measurements. Measuring methods and apparatus are also discussed. (J.R.D.)

2069 (UCRL-Trans-856(L)) STUDY OF ALKALINE-EARTH PHOSPHORS WHICH HAVE HIGH SENSITIVITY TO INFRA-RED RAYS. V. L. Levshin, V. V. Antonov-Romanovskii, Z. L. Morgenshtern, and Z. A. Trapeznikova. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Berkeley) from Zh. Eksperim. i Teor. Fiz., 17: 949-63(1947). 39p. (Includes original, 15p.).

A type of alkaline-earth phosphor was obtained which possesses a large accumulation capacity and sensitivity to infrared rays. The properties of the phosphors studied include the absorption and emission spectra, the flash output in relation to the infrared rays, and the accumulation capacity. The role of the main component parts of the phosphors was established. The emission and absorption spectra were determined by the first activator: Ce or Eu. The position of the spectrum is also dependent on the basic substance. The second activator, Sm, conditions the high sensitivity of the phosphors in infrared rays. On the basis of the results obtained, the mechanism of lumination of the phosphors is discussed. (M.C.G.)

2070 (UCRL-Trans-874(L)) PROOF OF THE IMPOSSIBILITY OF ERGODIC MECHANICAL SYSTEMS. M. Plancherel. Translated by Stephen G. Brush (Univ. of California, Lawrence Radiation Lab., Livermore) from Ann. Physik, 42: 1061-3(1913). 4p.

The proof is shown by use of equations of motion in which G is the part of the energy surface S that lies inside a 2n-dimensional sphere. The discussion leads to the conclusion that the part of any orbit curve of a system that lies in the region G forms a null set in G. Since G is not a null set, the proof follows. (J.R.D.)

2071 BACKGROUND INTENSITY OF ELECTRONS SCATTERED FROM SOLIDS. Russell A. Bonham (Naval Research Lab., Washington, D. C. and Indiana Univ., Bloomington). Acta Cryst., 15: 1046-7(Oct. 10, 1962). (In English)

It is shown that for film thicknesses less than 100 Å, the shape of the background intensity can be fitted with a theoretical background made up of only thermal diffuse and inelastic scattering components. For Au, Ag, and Al foils, theoretical background intensities were calculated and compared with the experimental data of Lennander. The agreement is good, and it is concluded that the fact that the intensity fall-off is less rapid than s^{-4} is chiefly due to the thermal diffuse scattering. (D.L.C.)

2072 DERIVATION OF MAXWELL'S EQUATIONS AND THE BOUNDARY CONDITIONS FROM COULOMB'S LAW. T. A. Green (Wesleyan Univ., Middletown, Conn.). Am. J. Phys., 30: 788-95(Nov. 1962).

It is shown that certain methods used to derive Maxwell's equations and the boundary conditions from Coulomb's law are mathematically unsound. One line of argument fails as a proof because it depends on the unwarranted extension of Maxwell's equations in integral form from the case of N point charges to that of continuous volume and surface distributions of charge. Another argument fails because it rests on unwarranted differentiations of improper integrals and the application of Gauss' and Stokes' theorems to situations in which the standard proofs of these theorems do not hold. An alternative elementary approach is presented. (auth)

2073 FURTHER REMARKS ON THE ZEROTH LAW. Louis A. Turner (Argonne National Lab., Ill.). Am. J. Phys., 30: 804-6(Nov. 1962).

The zeroth law of thermodynamics is shown to be a consequence of the absence of appreciable long-range forces between different portions of bodies of the kind usually under consideration in thermodynamic discussion. (auth)

2074 PLASMA RESONANCE IN THE ELECTRODYNAMICS OF METAL FILMS. Richard A. Ferrell and Edward A. Stern (Univ. of Maryland, College Park). Am. J. Phys., 30: 810-12(Nov. 1962).

When a fast electron passes through a thin metal film it can excite plasma oscillations, which then re-radiate the energy in the form of photons. The emitted radiation appears as a more or less sharp spectral line whose width is the sum of the intrinsic damping rate and the radiative natural line breadth. A completely equivalent formalism is provided by the extension of the theory of transition radiation (semi-infinite metal), to the case of a slab of metal bounded by two parallel planes. In the ideal case of a metal whose dielectric constant contains only a real lossless part, and no imaginary absorptive part, the predicted breadth and strength of the spectral line are the same in both theories. A further phenomenon suggested by the plasma-oscillation point of view is the possibility of a resonance in the reflection coefficient of a thin metal film at the plasma frequency, brought about by the collective response of the conduction electrons. The height and breadth of this resonance are computed, and may be observable in relatively ideal cases. (auth)

2075 UTILIZATION OF A SHOCK TUBE FOR MEASUREMENT OF THE ELECTRIC CONDUCTIVITY OF ION-

IZED AIR. [PART] II. Pierre Valentin and Claude Fauquignon (Commissariat à l'Énergie Atomique, Paris). Ann. Phys. (Paris), 7: 123-30(Mar.-Apr. 1962). (In French)

The results of two series of measurements on the electric conductivity of ionized air (initially under 1 mm and 1 cm of Hg) are reported. The profile of the conductivity in the region of relaxation behind the shock wave was determined. (J.S.R.)

2076 AN INVESTIGATION ON LATENT IMAGE FADING IN ILFORD K.5 EMULSIONS. Goeran Leide (Univ. of Lund, Sweden). Arkiv Fysik, 22: 147-73(1962). (In English)

Fading in Ilford K.5 emulsions is investigated by blob counting and track photometry on proton tracks. The results cover fading values for energy losses between 1.2 and 20 kev/μ, temperatures between −16 and +30°C, and relative humidities between 30 and 75%. A method of correcting for fading is presented. The order in which the grains of a given track disappear in the course of fading seems to be independent of the conditions of storage. From this observation the temperature and humidity dependences are derived. Fading increases exponentially with the temperature and with the concentration of moisture in the gelatin. The exponent is discussed. Oxygen seems to be of little importance for the process. The significance of the results for the theory of fading is discussed. (auth)

2077 ON THE SPECTRUM OF NEUTRAL BORON, B I. Per Gunnvald and Lennart Minnhagen (Univ. of Lund, Sweden). Arkiv Fysik, 22: 327-31(1962). (In English)

Various methods to produce a bright and clean spectrum of neutral boron are investigated. A hot hollow cathode of pure crystalline boron proves to be appropriate. Lines in the photographic infrared and in the lead sulfide range are observed and classified, and $2s^2 3p\ ^2P$ levels are found. Part of the term system is analyzed on the basis of these lines. The $2s2p^2\ ^4P - 2s2p3s\ ^4P$ group is measured. (auth)

2078 REMARKS ON THE COHERENT X-RAY SCATTERING BY THE LITHIUM HYDRIDE CRYSTAL. A. Westin, I. Waller, and S. O. Lundqvist (Univ. of Uppsala). Arkiv Fysik, 22: 371-4(1962). (In English)

Coherent x-ray scattering by the LiH crystal is calculated using a charge distribution that follows from calculated electronic wave functions. The results have been compared with those found by estimating the charge distribution using a simplified crystal field approach. The results agree, probably within the experimental uncertainty except for the lowest and possibly next lowest order reflection. (auth)

2079 SEEDING OF GASES FOR MAGNETOHYDRODYNAMIC APPLICATIONS. R. T. Foley and T. A. Vanderslice (General Electric Co., Schenectady, N. Y.). ARS (Am. Rocket Soc.) J., 32: 1573-6(Oct. 1962).

To achieve sufficiently high electron concentrations at reasonable temperatures for MHD applications, a general approach using seeding compounds rather than elements is discussed together with an extensive survey of the literature. Several examples are given in which the ionization potential of a compound is lower than the elements composing the compound. A trend in the ionization potential to decrease with decreasing valency unsaturation is noted, and some evidence for this is given. (auth)

2080 THE FRICTION OF CLEAN METALS IMMERSED IN LIQUID SODIUM. N. C. Balchin (Cambridge Univ., Eng.). Brit. J. Appl. Phys., 13: 564-9(Nov. 1962).

An apparatus for the measurement of friction is described. Specimens are heated in a high vacuum ($\sim 10^{-6}$ torr) to remove surface contamination such as oxide films and then immersed in liquid sodium. The friction between the specimens was measured both when they were dry and after immersion at temperatures from 100–190°C. In general, for specimens in liquid sodium, the frictional force was no longer proportional to load. Above a certain critical load, 10–40 g, depending on the specimen, the coefficient of friction increased and asymptotically approached a higher constant value, about two-thirds of the dry friction. The results are consistent with the formation of a thin layer of a double oxide on the surface of the specimen by a chemical reaction between the specimen, the liquid sodium, and sodium oxide dissolved in the latter. (auth)

2081 CONCEPTS OF SHOCK WAVE PROPAGATION. George E. Duvall (Stanford Research Inst., Menlo Park, Calif.). Bull. Seismol. Soc. Am., 52: 869-93(Oct. 1962).

The aspects of shock wave propagation which differ qualitatively from linear wave propagation are discussed and illustrated. Amplitude attenuation, energy dissipation, and their interrelations, spectral intensity distribution and its variation with distance, and the relations of wave structure to thermodynamic, shear, and time-dependent material properties are included. Pertinent formulas are derived and calculations are given for a rigid-locking solid. The concentration of energy at low frequencies as the wave progresses, and upper limits for the rates of attenuation of peak shock pressure in plane and spherical geometries are provided. (auth)

2082 DETERMINATION OF THE INERTIAL EFFECTS OF SPIN FROM POSTULATES OF THE DIRAC THEORY OF THE ELECTRON. Oliver Costa de Beauregard (Institut Henri Poincare, Paris). Cahiers Phys., 16: 153-64 (Apr. 1962). (In French)

The concept of spin density in quantum electrodynamics is developed and is used to deduce the asymmetry of the inertial tensor of an electronic fluid. This asymmetry determines the so-called "inertial effect of spin." The effects of translatory motion on the inertial effect of spin are examined. (T.F.H.)

2083 SOME RECENT DEVELOPMENTS IN THE STATISTICAL QUANTUM MECHANICS OF A SYSTEM OF INTERACTING PARTICLES. Claude Bloch (Centre d'Etudes Nucléaires, Saclay, France). Cahiers Phys., 16: 236-42 (June 1962). (In French)

Field theoretical methods are applied to the calculation of the partition function of macroscopic systems of interacting particles. Perturbation calculations are carried out in the second-quantization formalism, in powers of the interaction. (T.F.H.)

2084 REMARKS ON THE ASPECTS OF THE CATHODIC PULVERIZATION PHENOMENON IN AUTONOMOUS CORONA DISCHARGE WITH NEGATIVE POINT. Georges Buchet, Max Goldman, Alice Goldman, and Jean Reinhardt (C.N.R.S., Ivry, Seine, France). Compt. Rend., 255: 480-2(July 16, 1962). (In French)

On the basis of the rate of cathodic pulverization observed in negative corona discharge, exceptionally high potential gradients should be established at the point, in support of the hypothesis advanced (Compt. rend., 254: 2946(1962)). A reconciliation was made with Trichel pulses. Field emission is used. (tr-auth)

2085 LOW TEMPERATURE TECHNIQUES IN NUCLEAR RESEARCH. Louis Weil (Faculté des Sciences, Grenoble, France). Ind. At., 6: 53-8(1962). (In French)

Some applications of very low temperatures to the study of solid state physics and nuclear physics are described. Some of the apparatus used is discussed. (tr-auth)

2086 PHYSICAL PHENOMENA AT LOW TEMPERATURES. Lucienne Couture (Faculté des Sciences, Paris) and Rodolphe Spoendlin. Ind. At., 6: 59-69(1962). (In French)

The most remarkable phenomena in the low temperature region are described. An interpretation using atomic models is indicated. (tr-auth)

2087 ON THE STATIONARY MAGNETOHYDRODYNAMIC PROBLEM IN PRESENCE OF TWO-COORDINATES. INTERACTIONS OF CONDUCTING FLUID FLOWS. V. S. Tkalich. Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Mekhan. i Mashinostr., No. 5, 32-8(Sept.-Oct. 1962). (In Russian)

An analysis was made of the stationary problem with one quasicyclic coordinate. Solutions were constructed for the case of dissipation, where the current function satisfies the Helmholtz equation. Formulas were derived for the raising force and its moment in motions close to potential. (tr-auth)

2088 THEORETICAL VIBRATIONAL ENERGY LEVELS OF H_2 ASSOCIATED WITH VARIOUS COMBINATIONS OF MOLECULAR-ORBITAL CONFIGURATIONS. Gerard M. Leies (Georgetown Univ., Washington, D. C.). J. Chem. Phys., 37: 1418-24(Oct. 1, 1962).

A theoretical examination was made of the influence of various MO configurations on the spacing of the vibrational levels of H_2. Eleven previously determined potential curves for the H_2 ground state, based upon LC STO MO wavefunctions with configuration interaction, were used to calculate vibrational-energy levels and their first differences ΔG. Comparison of the 11 curves of ΔG vs vibrational quantum number v shows that only when the wavefunction contains the configuration $(\sigma_u 1s\sigma_u 1s')$ does the ΔG curve have a shape similar to that of the experimental ΔG curve. The combination of $(\sigma_g 1s\sigma_g 1s')$ and $(\sigma_u 1s\sigma_u 1s')$ provides left-right correlation or variable ionicity and this ionicity is found to vary in the same manner as the curvature of the ΔG curve. The addition of $(\sigma_g 2s\sigma_g 2p)$, which gives in-out correlation, and $(\pi_u 2p\bar{\pi}_u 2p)$, which provides angular correlation, to the wavefunction raises the ΔG curve especially at large v. The use of ΔG curves obtained from simple wavefunctions to estimate dissociation energies is discussed. (auth)

2089 THERMAL AND MAGNETIC STUDY OF CRYSTAL FIELD SPLITTINGS IN THULIUM ETHYLSULFATE. B. C. Gerstein, L. D. Jennings, and F. H. Spedding (Ames Lab., Ames, Iowa). J. Chem. Phys., 37: 1496-1508(Oct. 1, 1962). (IS-245)

The heat capacity and principal susceptibilities of thulium ethylsulfate were measured in the range 15 to 300°K and 1.3 to 200°K, respectively. The heat capacity of lutetium ethylsulfate was measured in the range 15 to 300°K. The contribution of the 4f electrons in Tm to the heat capacity of thulium ethylsulfate was evaluated experimentally by making an assumption concerning the difference in the lattice heat capacities of Tm and Lu ethylsulfates. The contribution of the 4f electrons in Tm to the heat capacity and principal susceptibilities was calculated using the angular part of the crystal field matrix elements calculated by Stevens and Elliott [K. W. H. Stevens, Proc. Phys. Soc. (London) A65, 209 (1952). R. J. Elliott, Revs. Modern Phys. 25, 167 (1953); R. J. Elliott and K. W. H. Stevens, Proc. Roy. Soc. (London) A219, 387 (1953); A218, 553 (1953)], and two sets of crystal field parameters currently available in the literature [E. Y. Wong and I. Richman, J. Chem. Phys. 34, 1182 (1961); J. B. Gruber and J. G. Conway, ibid. 32, 1531 (1960)]. The experimental results indicate that the crystal field parameters of Wong and Richman are more nearly correct than those of Gruber and Conway. (auth)

2090 APPLICATION OF CONFIGURATION INTERACTION TO THE 2^3S STATE OF HELIUM. H. L. Davis (Sandia Corp., Albuquerque, N. Mex.). J. Chem. Phys., 37: 1508-9(Oct. 1, 1962).

The method of configuration interaction is applied to the 2^3S state of the helium atom. The final set of 80 configurations gives an energy of −2.1752246 a.u. for this state without complete optimization of all the variational parameters. This value is to be compared with Pekeris' extrapolated value of −2.1752294 and his 125 function basis value of −2.1752210. Thus, it is concluded that hope still exists to obtain wave functions by the configuration interaction method which would compare favorably with Pekeris' extrapolated values. (auth)

2091 KINETIC THEORY OF DENSE FLUIDS. XII. ELECTRONIC AND IONIC MOTION IN LIQUID He^4I AND LIQUID He^3. H. T. Davis, Stuart A. Rice, and Lothar Meyer (Univ. of Chicago). J. Chem. Phys., 37: 1521-7 (Oct. 1, 1962).

The mobilities of positive and negative charge carriers in liquid He^3 and He^4I are calculated and the resultant agreement with experiment is excellent. The negative carrier is taken to be an electron. Due to electrostriction and density fluctuations the effective mass of the electron is of the order of 100 electron masses. In addition, the disorder of the liquid leads to incoherences in the scattering of the electron from atomic pseudopotentials. The positive carrier is taken to be He_2^+. An extension of the theory of Rice and Allnatt, using the ideas introduced by Mazo and Kirkwood, leads to a formula for the mobility in terms of a quantum-mechanical temperature. Electrostriction increases the density about an ion and the dissipation arises about equally from the short-range repulsive forces and the Coulomb and van der Waals attractive forces. Both calculations involve only basic considerations and there are no adjustable parameters in the theory. The computed effective mass of the negative carrier in He^3 at 3.00°K and 2-atm pressure is 105 electron masses: The observed effective mass is 97 electron masses. For the negative carrier in He^4I at 4.2°K and 1-atm pressure the computed and observed effective masses are 149 and 128 electron masses, respectively. In the case of the positive ion, the observed mobility at 2.2°K and 1-atm pressure in He^4 is 5.6×10^{-2} $cm^2\ v^{-1}\ sec^{-1}$ while the computed value is 5.2×10^{-2} $cm^2\ v^{-1}\ sec^{-1}$. New comments and an alternative interpretation of the electron effective mass are also given. (auth)

2092 λ ANOMALY IN THE HEAT CAPACITY OF PARA ENRICHED SOLID DEUTERIUM. George Grenier and David White (Ohio State Univ., Columbus). J. Chem. Phys., 37: 1563-4(Oct. 1, 1962).

The heat capacity of 81.3 ± 1% para-deuterium was observed to undergo a very sharp λ transition in the solid with the maximum at 2.83°K. The drop in heat capacity from the maximum occurs over 0.01° or less. (D.L.C.)

2093 ELECTRON AND NUCLEAR MAGNETIC INTERACTION IN TRIPLET STATES OF VARIOUS ORGANIC PHOSPHORS. Bernard Smaller (Argonne National Lab., Ill.). J. Chem. Phys., 37: 1578-9(Oct. 1, 1962). (TID-15758)

Paramagnetic resonance measurements were carried out on the triplet states of a large number of organic phosphors. The results are reported as zero-field splittings and forbidden transition linewidths. The effects of deuteration on lifetime and forbidden transition linewidth were also studied for benzene and naphthalene. (D.L.C.)

2094 EFFECT OF TOPOGRAPHY OF THE MAGNETIC FIELD ON THE PROPERTIES OF A SOURCE OF

THE DUOPLASMATRON. R. Becherer, G. Gautherin, and A. Septier (Faculté des Sciences, Paris). J. Phys. Radium, 23: Suppl. to No. 6, 121A-28A(June 1962). (In French)

Although numerous publications have been devoted to the "Duoplasmatron" ion source, the exact relation between the properties of the extracted ion beam and many geometrical and electrical parameters is not yet well understood. The influence of the intensity and configuration of the magnetic induction B in the vicinity of the extraction aperture on the intensity and angular aperture of the ion beam is studied. By the use of different magnetic circuits, it was possible to determine the best structure giving higher current and smaller aperture: it is necessary to put the maximum value of B in the extraction aperture itself, and to have a value of B as great as possible in the acceleration space. (auth)

2095 CRYSTALLOGRAPHIC DATA FOR THE HEXAGONAL CRYSTAL SYSTEM. R. E. Frounfelker, M. A. Seitz, and W. M. Hirthe (Marquette Univ., Milwaukee). Nucl. Sci. Eng., 14: 192-6(Oct. 1962).

Interplanar angles for the hexagonal system were calculated on a high-speed digital computer for axial ratios c/a from 1.500 to 2.000 at intervals of 0.010. The results, rounded off to the third decimal place, are tabulated, and a nomogram is also given for determining the angles within 0.5°. A table of interplanar angles is given for the elements Dy, Hf, Be, Gd, Y, and Zr. (D.L.C.)

2096 DETERMINATION OF FISSION PRODUCT BACKGROUND IN THE GAMMA COINCIDENCE TECHNIQUE FOR U^{238} ACTIVATION MEASUREMENTS. Hector M. Antúnez (General Electric Co., Pleasanton, Calif.). Nuclear Sci. and Eng., 14: 8-10(Sept. 1962).

The U^{238} neutron capture rate is usually measured in fuels by counting the activity of 2.3-day Np^{239}. A method is usually used which consists of counting the coincidence between two photons in the neighborhood of 105 kev. But with this technique there is a significant fraction F of the true coincidence counting rate due to U^{235} fission product decay. A method is described for measuring F. Two U samples of different enrichments were irradiated in a thermal spectrum and F was calculated from counting rates. (W.D.M.)

2097 RESONANCE AND TOTAL U^{238} ACTIVATION IN THIN NATURAL URANIUM–NIOBIUM FUEL PLATES. J. J. Kepes, L. A. Mikoleit, and R. G. Serenka (Westinghouse Electric Corp., Pittsburgh). Nuclear Sci. and Eng., 14: 11-16(Sept. 1962).

Differential measurements of the epicadmium and total U^{238} radiative capture have been obtained in thin natural uranium–niobium plates and compared to several theoretical models. These fuel elements were located in Zircaloy-2 boxes, which in turn were placed in a light water moderated critical assembly at ambient temperatures. A Monte Carlo calculation with the assumption of a smooth 3.3 b contribution predicted the spatial epicadmium activation through a natural uranium fuel plate positioned in the center of the Zircaloy-2 box. It was observed that the integrated epicadmium U^{238} radiative capture in the end fuel plate of the Zircaloy-2 box was 1.27 times the capture in the center fuel plate. This sharp end-to-center dipping was due to a water channel located next to the fuel box. An analytic calculation based on the thin resonance theory of Stein gave a value of 1.16 for this end-to-center ratio. The experimental integrated values for ρ^{28}, the ratio of epicadmium to thermal captures, were 0.893 ± 0.009 in the center fuel plate, 0.765 ± 0.014 in the second from the end plate, and 0.851 ± 0.011 in the end plate. The value of ρ^{28} obtained using a diffusion theory approximation for these plates was 4.7, 7.5, and 21.7% below experiment. The prediction in the end plate was improved when the Stein theory was utilized to calculate the resonance capture. (auth)

2098 ELECTRICAL EFFECTS PRODUCED BY PLASTIC DEFORMATION IN SODIUM CHLORIDE CRYSTALS. J. E. Caffyn and T. L. Goodfellow (Northampton Coll. of Advanced Tech., London). Phil Mag. (8), 7: 1257-62(Aug. 1962).

The potential developed across the faces of a single crystal of sodium chloride during plastic deformation was investigated in specimens containing known amounts of either calcium or strontium impurity. The stress at which this phenomenon first appears is found to be correlated with the yield stress of the material. The effect of size and shape of specimen and of rate of loading was also studied. (auth)

2099 THE INFLUENCE OF THERMAL VIBRATION ON FOCUSED COLLISION SEQUENCES. R. S. Nelson, M. W. Thompson, and H. Montgomery (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phil. Mag. (8), 7: 1385-1405(Aug. 1962). (AERE-R-4044)

Small Au crystals were bombarded with 43-kev Ar^+ ions, and sputtered deposit patterns were obtained which show preferential ejection to occur in directions close to the (110) crystal axes. The deposits were analyzed to give the mean squared angular deviation from the (110) axis, and the effect on this of crystal temperature was studied over the range 80 to 1170°K. The square of the deviation increased almost linearly with temperature up to 800°K, but above this temperature the increase was more rapid. Consideration is given to several mechanisms which might cause scattering of the focused collision sequences responsible for ejection, and it is concluded that the most important is the lateral displacement of atoms from the focusing line by thermal motion. A theory of the effect is developed which predicts angular deviations in agreement with experiment, provided that the larger vibration amplitudes thought to occur on surface atoms are used. The effect of thermal scattering on the attenuation of focused collision sequences is also considered and range–energy curves calculated. Some implications in the fields of radiation damage and sputtering are considered. It is shown that such scattering renders mass transport by (110) sequences very inefficient. Furthermore, both the rate of formation of defects by radiation, and their spatial distribution, should be affected by temperature. As a consequence of the shortening of the sequences' range, a slow decrease in sputtering ratio with temperature is predicted. (auth)

2100 FOCUSED COLLISION SEQUENCES IN ALUMINIUM. R. S. Nelson and M. W. Thompson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phil. Mag. (8), 7: 1425-8(Aug. 1962). (AERE-R-4014)

Focused collision sequences in an Al crystal were studied by sputtering with focused 50-kev Ar^+ ion beams. The ejection of atoms from the (110), (100), and (111) directions was compared; most of the sputtered atoms come from (110) sequences. The angular deviation of ejected atoms about the direction of perfect focusing is greater for (100) than (110), and possible reasons for this are discussed. (D.L.C.)

2101 AN EQUATION FOR DESCRIPTION OF FLUCTUATION PHENOMENA AND TURBULENCE IN GASES. G. Ludwig (Universitat Berlin). Physica, 28: 841-60(Sept. 1962). (In English)

Boltzmann's collision equation yields a deterministic course for the function $f(r,v,t)$, where $f(r,v,t)\Delta r\Delta v$ is equal to the number of atoms in the interval $\Delta r\Delta v$ at time t. Instead of this function, a probability density $\rho[f(r,v),t]$ on

Boltzmann's distribution function f(r,v) is considered. The density ρ can be regarded as a certain macroscopic coarsening of the Liouville density. With the assumption that the probability density ρ satisfies a so-called "master equation," an explicit equation is outlined for ρ. The evaluation of this equation makes possible the description of the temporal development and the formulation of fluctuation phenomena in gases. (auth)

2102 DISTRIBUTION IN SPACE OF THE EARTH'S OUTER RADIATION BELT AND THE AURORA ZONE. E. (Ye.) V. Gorchakov. Planetary and Space Sci., 9: 503-5(Aug. 1962). (Translated by H. S. H. Massey from Iskusst. Sputniki Zemli, No. 8, p.81, 1961).

Scintillation-counter measurements from about 200 satellite passes are used to define the extent of the outer radiation belt, at heights of 300 to 600 km in the northern hemisphere and 1500 km in the southern hemisphere. Lines defining regions of equal auroral probability are defined for both hemispheres. (T.F.H.)

2103 DISCONTINUITY SURFACES WITH ENERGY RELEASE (ABSORPTION) IN MAGNETIC HYDRODYNAMICS. A. A. Barman. Priklad. Mat. i Mekhan., 26: 801-10 (Sept.-Oct. 1962). (In Russian)

Studies are made of discontinuities with exothermal and endothermal reactions in an electric conducting medium with an infinite conductivity in arbitrary magnetic field. The studied energy releasing (absorbing) discontinuities are not limited to the released energy magnitude or direction or the magnetic field intensity. It is shown that two types of detonation and two types of shock ionization are possible in general cases when the reaction zone follows, respectively fast or slow shock waves. Four types of burning discontinuities were observed (two compressed and two rarefied). The abrupt changes in density, compression, magnetic field, gas velocity, temperature, and enthropy behind the discontinuity were investigated as functions of intensity and energy released. (R.V.J.)

2104 ON SETTING UP A PROBLEM ON MAGNETOHYDRODYNAMICS OF BOUNDARY LAYERS. G. A. Lyubimov. Priklad. Mat. i Mekhan., 26: 811-20(Sept.-Oct. 1962). (In Russian)

General aspects and equations are given for setting up a problem on the magnetohydrodynamics of boundary layers in incompressible fluid. (R.V.J.)

2105 ON ONE AUTOMODEL SOLUTION FOR MAGNETOHYDRODYNAMIC EQUATIONS. A. A. Bogacheva and M. D. Ladyzhenskii. Priklad. Mat. i Mekhan., 26: 821-35 (Sept.-Oct. 1962). (In Russian)

Streamlining by incompressible, plane, stationary, supersonic flow over a wedge with surface currents flowing perpendicular to the plane flow and the intensity square in reverse proportion to the distance from the wedge vertex was investigated. The gas before the shock wave is assumed to be nonconducting and of finite conductivity at the region of disturbed flow. The transition through the shock wave was described by the same equations used in the case without magnetic field. An automodel solution of magnetohydrodynamic equations describing the flow near the wedge apex and presenting a generalized exact solution for wedge streamlining in the absence of magnetic field was found for the given assumption. (R.V.J.)

2106 UNSTABLE PLANE-PARALLEL VISCOUS FLOW OF ELECTRICALLY CONDUCTING GAS CONSIDERING CONDUCTANCE ANISOTROPY. Ya. S. Uflyand. Priklad. Mat. i Mekhan., 26: 836-41(Sept.-Oct. 1962). (In Russian)

Transition processes in ionized viscous gas flow between parallel conducting plates are studied in the presence of magnetic fields. It is assumed that pressure drops $P_x(t)$ and $P_Y(t)$ are found along x and y, moreover, the homogeneous magnetic field is directed perpendicular to the walls. It is shown that the transition processes have characteristics of attenuating oscillations, and the studies were made of the viscosity effects on their shape. The difference between the flow with anisotropic conductivity and an ordinary isotropic case (with a periodic motion of the weak by conducting medium) was established. (R.V.J.)

2107 REFLECTION OF MAGNETOSONIC WAVES. L. Ya. Kosachevskii. Priklad. Mat. i Mekhan., 26: 842-53 (Sept.-Oct. 1962). (In Russian)

A problem on magnetosonic wave reflection from a conducting fluid and an elastic medium interface was resolved. Formulas were derived for the reflection and refraction coefficients. Surface waves on the elastic semi-space free boundary were analyzed, and the velocity of these waves in a weak field was found. (tr-auth)

2108 ON THE MOTION OF A PLANE PISTON IN A FINITE CONDUCTANCE MEDIUM CONSIDERING THE EFFECT OF ELECTROMAGNETIC FIELD. V. P. Karlikov and V. P. Korobeinikov. Priklad. Mat. i Mekhan., 26: 970-2(Sept.-Oct. 1962). (In Russian)

The steady motion of a plane infinitely conducting piston in a finite conductance medium varying along the axis with the motion of the piston was analyzed. The problem is confined to the regions between the magnetic wave and shock wave and between the shock wave and the piston. (R.V.J.)

2109 AN APPROXIMATE CELL MODEL FOR LIQUID HYDROGEN. [PART] I. Douglas Henderson, Sungwoon Kim, and Henry Eyring (Univ. of Idaho, Moscow and Univ. of Utah, Salt Lake City). Proc. Natl. Acad. Sci. U. S., 48: 1753-9(Oct. 1962).

An approximate cell model of liquid hydrogen was formulated and investigated for use in calculating thermodynamic properties. In the cell model, each molecule is regarded as restricted to a cell or cage formed by its nearest neighbors. The model is obviously deficient since it does not provide for enough disorder and leaves out any correlations in the motions of the molecules. The quantum cell model does appear to predict quantum corrections correctly, though densities are too low and vapor pressures are too high. The calculated critical properties, based on the classical Lennard-Jones and Devonshire theory are listed together with corresponding experimental results. The agreement between calculations and the experimental critical properties of H_2 is of the same order of correctness as is agreement between the corresponding classical quantities. (C.H.)

2110 QUANTIZATION OF COUPLED ORBITS IN METALS. A. B. Pippard (Cambridge Univ., Eng.). Proc. Roy. Soc. (London), Ser. A, 270: 1-13(Oct. 30, 1962).

The failure of semi-classical quantization of electron orbits in metals in the presence of a strong magnetic field (magnetic breakthrough) is discussed in an elementary fashion by means of first-order perturbation theory. The interference effects that arise when orbits about different centers are coupled are reproduced in a simple network analog. Exact analysis of the network shows how the energy levels are broadened by the coupling and eventually reform into a different set of levels. Fourier analysis of the level density reveals the structure to be expected in the de Haas-van Alphen effect when magnetic breakthrough is significant. It is concluded that in principle the whole evolution of the level system should be observable. (auth)

2111 GRAVITATIONAL WAVES IN GENERAL RELATIVITY. VIII. WAVES IN ASYMPTOTICALLY FLAT

SPACE-TIME. R. K. Sachs (King's Coll., London). Proc. Roy. Soc. (London), Ser. A, 270: 103-26(Oct. 30, 1962).

Gravitational fields containing bounded sources and gravitational radiation are examined by analyzing their properties at spatial infinity. A convenient way of splitting the metric tensor and the Einstein field equations, applicable in any space-time, is first introduced. Suitable boundary conditions are set. The group of coordinate transformations that preserves the boundary conditions is analyzed. Different possible gravitational fields are characterized intrinsically by a combination of characteristic initial data and Dirichlet data at spatial infinity. To determine a particular solution four functions of three variables and three functions of two variables must be specified; these functions are not subject to constraints. A method for integrating the field equations is given; the asymptotic behavior of the metric and Riemann tensors for large spatial distances is analyzed in detail; the dynamical variables of the radiation modes are exhibited; and a superposition principle for the radiation modes of the gravitational field is suggested. The group of allowed coordinate transformations contains the inhomogeneous orthochronous Lorentz group as a subgroup; each of the five leading terms in an asymptotic expansion of the Riemann tensor has the algebraic structure predicted from analyses of the Petrov classification; gravitational waves appear to carry mass away from the interior; and time-dependent periodic solutions of the field equations that obey the stated boundary conditions do not exist. It is found that the general fields studied are similar to certain axially symmetrical fields. (auth)

2112 THEORY OF SPIN-ORBIT COUPLING IN ATOMS. I. DERIVATION OF THE SPIN-ORBIT COUPLING CONSTANT. M. Blume and R. E. Watson (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Proc. Roy. Soc. (London), Ser. A, 270: 127-43(Oct. 30, 1962).

An exact expression for the spin-orbit coupling constant is derived within the Hartree-Fock description of the atom by considering the two-body mutual spin-orbit interaction between electrons. The interaction is rewritten in tensor operator form and the contribution of outer electron-core interactions to the coupling constant is calculated. It is found that the expression $(\partial V/r\partial r)$, where V is the Hartree potential, is only approximate. Certain exchange type terms, which arise because a two-body interaction and a determinantal wave function are studied, must also be included. These exchange terms are not simply related to the ordinary electrostatic exchange. The resulting expression for the spin-orbit coupling constant is given in terms of radial integrals, which can be calculated using Hartree or Hartree-Fock wave functions. The effective magnetic Hamiltonian to be used for the calculation of matrix elements within an atomic configuration is also discussed. (auth)

2113 DIRECT TRANSFORMATION OF HEAT INTO ELECTRICITY WITH THE AID OF THERMIONIC CONVERTERS WITH CESIUM ATMOSPHERE. Pierre Boyer. Rev. Gen. Electron., 16: No. 184, 17-22(Mar. 1962). (In French)

The review of the direct transformation of heat into electricity is divided into two basic sections—electronic emission with surface ionization and surface ionization of cesium on tungsten. A number of specific applications to converters is given. A very recent biography is appended. (auth)

2114 PRODUCTION OF A BEAM OF HYDROGEN ATOMS IN THE EXCITED METASTABLE STATE 2S. L. Colli, P. G. Sona, G. Bassani, F. Cristofori, M. Oberto Franceschetti, and G. Frigerio (Università, Milan and CISE, Milan). Ric. Sci., (2), 2: 82-7(1962). (In English)

The production of a beam of hydrogen atoms, excited in the metastable state 2S by means of a charge exchange mechanism, was studied. A beam of protons of 13 kev passes through a chamber containing a gas at a pressure ranging from 10^{-3} to 10^{-2} mm Hg. The absolute number of the metastable atoms produced, and the ratio between this number and the total number of hydrogen atoms in any state, were measured for different gases at various pressures. (auth)

2115 THE QUESTION OF THE EPITAXY OF METALLIC AND IONIC CRYSTALS. I. I. Papirov and L. S. Palatnik (Khar'kov Polytechnic Inst.). Soviet Phys.-Cryst. (English Transl.), 7: 222-5(Sept.-Oct. 1962).

In regular intergrowths of metallic and ionic crystals, and also in certain other cases of the epitaxy of different substances, pseudomorphism of the contact plane is not observed. The orientation produced does not correspond to the minimum possible geometrical difference in the parameters of the adjacent lattices. The structural criterion is examined with an explanation for the observed orientation, and a possible mechanism is proposed for the formation of oriented layers for the above-mentioned case of "partial epitaxy." (auth)

2116 SOME PECULIARITIES OF THE GROWTH OF SINGLE CRYSTALS OF POTASSIUM NIOBATE AND TANTALATE. V. A. Timofeeva and A. S. Popova (Inst. of Crystallography, Academy of Sciences, USSR). Soviet Phys.-Cryst. (English Transl.), 7: 233-6(Sept.-Oct. 1962).

The systems $K_2O-Nb_2O_5$ and $K_2O-Ta_2O_5$ were investigated by the method of differential thermal analysis; a study was made of the conditions for growing single crystals of potassium niobate and tantalate by the method of crystallization from solution in molten solvents. The dielectric and piezoelectric properties of $KNbO_3$ crystals were studied. The dielectric constant, piezoelectric modulus d_{33}, and conductivity ρ_v were measured. (auth)

2117 AN X-RAY STUDY OF THE PHASE TRANSITION IN Sr_2FeTaO_6. M. F. Kupriyanov and E. G. Fesenko (Rostov-on-Don State Univ., USSR). Soviet Phys.-Cryst. (English Transl.), 7: 246-7(Sept.-Oct. 1962).

X-ray patterns showed that Sr_2FeTaO_6, tetragonal at low temperatures, changes to a cubic phase at ~250°C. The cell at room temperature has $a = 3.960 \pm 0.001$ Å and $c = 3.981 \pm 0.001$ Å, but at 250°C, $a = 3.973 \pm 0.001$ Å. (D.L.C.)

2118 ELECTRON TRANSITIONS IN COMPRESSED CESIUM AND RUBIDIUM. E. S. Alekseev and R. G. Arkhipov (Inst. of High Pressure Physics, Academy of Sciences, Moscow). Soviet Phys.-Solid State (English Transl.), 4: 795-7(Nov. 1962).

Electron transitions in cesium and rubidium are analyzed, under the influence of high pressures. It is shown that the transition occurs in cesium at a pressure of the order of 60,000 kg/cm^2 and in rubidium at 200,000 kg/cm^2. (auth)

2119 THE MOTIONS OF CHARGE CARRIERS IN GASES IN PULSING MAGNETIC FIELDS. Winfried Otto Schumann (Technische Hochschule, Munich). Z. Angew. Phys., 14: 512-16(Aug. 1962). (In German)

The motion of charged particles under the effect of crossed electric and magnetic fields, with phase displacement of 90°, was investigated. It was shown that the velocities remain constant only through shock absorption. In collision-free motion, the velocity increases linearly with time both in the direction of the electric field and perpendicular to the direction of the electric and magnetic fields. These infinitely increasing terms vanish only for given characteristic values of the frequency. While the motion in the direction of the electric field has an oscillatory char-

acter at all frequencies, the motion perpendicular to the magnetic and electric field at small frequencies ($\omega \ll \Omega_a$) has, in addition to an oscillating character, a linear motion at increasing frequency with a time-proportional velocity. The velocities remain constant through the effect of shock absorption. In addition to the oscillating component in the direction of the electric field, a translation motion decaying with time arises, that is, a finite particle displacement as the end effect, and also a time constant displacement velocity perpendicular to both fields. One component of the electric field is in phase with the magnetic field, so that as a result, there are oscillations in both directions and a translatory displacement with constant velocity perpendicular to both fields. (tr-auth)

2120 ANGULAR DISTRIBUTION OF THE ENERGY LOSS OF MEDIUM FAST ELECTRONS IN ANTIMONY. J. Geiger (Universität, Berlin). Z. Naturforsch., 17a: 696-9(Aug. 1962). (In German)

The angular distribution of electron energy loss in antimony layers was measured, and a typical energy spectrum for 25-kev electrons in a 300 Å Sb layer is shown. The dispersion constant was determined both experimentally and theoretically, and the values obtained are tabulated. The best agreement between these values was obtained when electron exchange was taken into consideration. The angular intensity of the scattering intensity was determined, and the experimental and theoretical values agreed. The results showed that dispersion of the energy loss followed the plasma theory. (J.S.R.)

2121 PRINCIPLES OF ELECTRODYNAMICS. F. Bopp (Universitllt, Munich). Z. Physik, 169: 45-52(1962). (In German)

It is customary in electrodynamics to proceed from the field equations and to consider them given more or less a priori. This has varying historical backgrounds. Since electromagnetic fields are not directly transmitted to us but only through their effects on charged bodies, the area of electrodynamics is clear when one proceeds, on the one hand, from the charges which are directly measurable and, on the other hand, on the forces on them which one can also measure without knowing the area of electrodynamics. In the following, electrodynamics are derived from the continuity equations and the expression for the Lorentz force under consideration of principles which are evident in the sense that one can have no other when the basic concepts of electrodynamics are excepted. (tr-auth)

2122 THE HYDRODYNAMIC MODEL OF QUANTUM MECHANICS. L. Jánossy (Hungarian Academy of Sciences, Budapest). Z. Physik, 169: 79-89(1962). (In German)

An attempt is made to transform mathematically the Schroedinger wave equation in such a way that the new form of wave equation corresponds to a classical motion equation of the hydrodynamic type. In order to give a complete picture it is necessary to repeat known results. But these results are perfected and polished. Only identical transformation and equations are considered which result essentially by a transformation of variables from the original equations. (J.S.R.)

2123 ANISOTROPY OF THE MOSSBAUER EFFECT IN β-Sn SINGLE CRYSTALS. N. E. Alekseyevskii, Tsui-Hieng Fang, V. G. Shapiro, and V. S. Shpinel. Zh. Eksperim. i Teor. Fiz., 43: 790-4(Sept. 1962). (In Russian)

The probability for resonance absorption, f', of 23.8-kev γ-quanta was measured in single crystal plates of white metallic tin cut out along various crystallographic planes. A large anisotropy of the effect was observed which did not change upon transition from a temperature of 293 to 77°K. The following ratio of the quantities f' in various plates was observed: $f'_{100} : f'_{101} : f'_{001} : f'_{\text{polycrys.}} = 1 : 0.95 : 0.75 : 0.80$. Differences in the positions of the absorption peaks and an asymmetry of the absorption lines have been found which can be explained by quadrupole splitting of the Sn^{119} nuclear level in the β-Sn crystal. (auth)

2124 THRESHOLD ABSORPTION OF INFRARED WAVES IN SUPERCONDUCTORS. V. L. Pokrovskii and M. S. Ryvkin (Inst. of Radiophysics and Electronics, Siberian Branch of the Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 43: 900-5(Sept. 1962). (In Russian)

It is shown that in superconductors at T = 0 and frequencies near the absorption threshold the absorption depth exceeds the field penetration depth. The frequency behavior of absorption near the threshold is determined for Pippard and London superconductors. (auth)

2125 CALCULATION OF THE PARAMETERS OF THE EXPERIMENTAL γ-QUANTUM RESONANCE ABSORPTION SPECTRUM IN CRYSTALS. G. A. Bykov and Tsiu-hien Fam (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 43: 909-18(Sept. 1962). (In Russian)

The parameters of the observed γ-quantum resonance absorption spectrum in crystals is calculated for single and split lines by taking into account self absorption in the source. (auth)

2126 ON THE ENERGY LOSS BY A CHARGED PARTICLE IN A MEDIUM AS THE RESULT OF EMISSION OF LONGITUDINAL WAVES. L. G. Naryshkina (Moscow Inst. of Physics Engineering). Zh. Eksperim. i Teor. Fiz., 43: 953-7(Sept. 1962). (In Russian)

The energy loss by a charged particle as a result of emission of longitudinal waves in a medium is considered. It is demonstrated that if the charged particle possesses proper vibrations, the latter may be amplified because of the interaction between the charge and medium. (auth)

2127 ANGULAR DISTRIBUTION OF PHOTOELECTRONS FROM THE K-SHELL. V. G. Gorshkov and A. I. Mikhailov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 43: 991-1004(Sept. 1962). (In Russian)

The angular distribution of photoelectrons from the K shell is obtained for γ-quantum energies above 0.5 Mev. The relative accuracy of the calculations is of the order of $(\alpha Z)^2$. The effect of screening is taken into account. The cross section for photoelectrons emitted in the direction of the incident photons can be represented in an analytic form with a relative accuracy of the order of αZ. The results of the numerical calculations agree with the experiments within the errors of the measurements. (auth)

2128 CESIUM VAPOR DIODES. T. L. Matskevich (Leningrad Ioffe Inst. of Physics and Tech.). Zh. Tekhn. Fiz., 32: 1139-41(Sept. 1962). (In Russian)

Descriptions are given of a simple device with a thorium oxide cathode capable of thermoelectric energy transformation with a yield of 0.5 v. The influence of external magnetic field, perpendicular to the electron motion, on the thermoelectric energy transformation oscillation amplitudes was determined. Volt-amp characteristics were measured at various magnetic field intensities. (R.V.J.)

2129 FLOW PHENOMENA OF PURE ^4He AND ^3He–^4He MIXTURES IN THE HELIUM II REGION. Frans Adrianus Staas. Thesis, Leiden, Rijksuniversiteit, 1961. 63p.

Attention is devoted to experimental methods, analyses, and results pertaining to: The viscosity of liquid He^3–He^4

mixtures in the He II region above 1°K; laminar and turbulent flow of He II in wide capillaries; and superfluid flow in wide capillaries. (T.F.H.)

2130 CONSTITUTION AND MAGNETIC SUSCEPTIBILITY OF THE VANADIUM–HYDROGEN SYSTEM. MAGNETIC PROPERTIES OF GADOLINIUM, EUROPIUM AND YTTERBIUM HYDRIDES. Richard Louis Zanowick. Thesis, Pittsburgh, Univ. of Pittsburgh, 1961. 80p.

An x-ray study was made of the structure and phase relations in the vanadium–hydrogen system, and the magnetic susceptibilities of these alloys were also determined. The magnetic behavior of europium, gadolinium, and ytterbium hydrides was examined from 4°K to room temperature. The hydrogen-metal alloys were prepared by conventional techniques in conventional vacuum systems. A partial phase diagram for the V–H system was determined for alloys containing up to 42 atomic per cent hydrogen and from room temperature to 205°C. In much of the composition and temperature ranges studied, the V–H system is composed of two phases. These are a body-centered cubic phase based on the vanadium structure and a body-centered tetragonal phase ($c/a \approx 1.1$) of nominally V_2H stoichiometry. The lattice parameter changes in both phases are shown as a function of temperature and hydrogen concentration. Results of magnetic studies of the V–H alloys at room temperature are consistent with the notion that the hydrogen enters the vanadium interstices as protons and the hydrogen electrons join the vanadium conduction band. A magnetic study of a body-centered tetragonal-phase sample shows the alloy exhibiting Pauli paramagnetism from 78°K to room temperature. Magnetic studies on gadolinium hydride suggest that the Curie point observed in elemental gadolinium is dependent upon the conduction band electrons for the magnetic interactions to take place. Hydrided gadolinium exhibited no Curie point, but had an effective magnetic moment comparable to that of gadolinium. These results suggest that the hydrogen in the hydrides is anionic being formed by the depopulation of the metal conduction band. Weakly paramagnetic ytterbium exhibits only slight changes on being hydrided. The changes observed in europium on hydriding are quite pronounced, and europium dihydride is strongly ferromagnetic at 20°K and lower. Metallic europium is observed to be either weakly ferromagnetic or paramagnetic in the same temperature range. The europium hydride results are still consistent with the formation of the hydride anion with the concurrent depopulation of the metallic conduction band. However, unlike the Gd–H system, the conduction band is apparently unnecessary for the magnetic interactions to take place in europium. (Dissertation Abstr., 23: No. 3, 1962)

2131 ELECTRON REQUIREMENTS OF BONDS IN METAL BORIDES. Robert William Johnson. Thesis, Ames, Iowa State Univ. of Science and Tech., 1962. 70p.

This study involved the preparation of YB_2, YB_4, YB_6, YB_{12}, CaB_6, SrB_6, and BaB_6, measurement of the Hall coefficients of the yttrium borides, and measurement of resistance vs temperature for the above alkaline earth hexaborides. Polycrystalline samples of CaB_6 and BaB_6 were obtained by reaction of powdered boron and metal vapor in a sealed Ta crucible at 1000 to 1500°C, followed by arc melting. Single crystals of SrB_6 were obtained by holding Sr and boron, contained in a sealed thick-walled Ta tube, in a temperature gradient from 1650 to 1800°C for four hours. The resistance vs temperature was measured up to 1185°C, and the slope of the curve was negative above 725°C, showing that SrB_6 is a semi-conductor. The energy gap calculated from the linear portion of a lnR vs 1/T curve was $\epsilon =$ 0.19 ev. Measurements of polycrystalline CaB_6 and BaB_6 gave similar results. Energy gaps obtained as above are: for CaB_6, $\epsilon = 0.20$ ev; for BaB_6, $\epsilon = 0.06$ ev. A new method for high temperature floating zone melting was developed for preparation of Hall effect samples of the yttrium borides. The zone is heated by an induction coil coupled with an r-f step-down transformer called an eddy current concentrator, and temperatures near 2600°C were easily obtained. The compounds were synthesized by arc melting together yttrium and "crystalline" boron and were fabricated into 1/4-in. diameter rods by melting into a groove in the plate of the arc melter. Zone melting was done with zone compositions different from that of the rest of the rod, so that the peritectics YB_6 and YB_{12} could be obtained by Mason and Cook's method. Single crystal samples of the non-cubics YB_2 and YB_4, and polycrystalline samples of the cubics YB_6 and YB_{12} were obtained. Sample cutting was done with a Servomet sparkcutter. The Hall coefficient of YB_2, measured with the magnetic field parallel to the c axis of the crystal, is $R_H = -20.5 \pm 2.5 \times 10^{-11}$ meter^3/coulomb. For YB_4 in a similar orientation, $R_H = -213 \pm 9 \times 10^{-11}$. For YB_6, $R_H = -44.7 \pm 2.2 \times 10^{-11}$. The YB_{12} sample contained a finely divided non-conducting second phase, and the Hall coefficient corrected for that condition is $R_H = -89 \pm 15 \times 10^{-11}$. The electrical resistivities in Ω-cm of the above samples are: CaB_6, ≈0.1; SrB_6, ≈0.2; YB_2, $39 \pm 3 \times 10^{-6}$; YB_4, $28.4 \pm 1.3 \times 10^{-6}$; YB_6, $40.5 \pm 1.6 \times 10^{-6}$; YB_{12}, $94.8 \pm 3 \times 10^{-6}$. According to LCAO treatments of boron atoms in the boride types MB_2, MB_4, MB_6, and MB_{12} by various authors, if M is a divalent metal, any of these borides should be a semiconductor, and if M is trivalent the compounds should have one metallic electron per metal atom. For YB_2, YB_6, and YB_{12}, Hall coefficients calculated on that basis from $R_H = 1/ne$ agree with the measured values within experimental error. The equation cannot be applied to YB_4 because a free electron Fermi surface for one electron per yttrium atom falls into four Brillouin zones. Indirect arguments for YB_4 based on its structural similarity to YB_2 and YB_6 lead to the conclusion that there is probably one electron per yttrium atom, in agreement with theory. (Dissertation Abstr., 23: No. 3, 1962)

2132 THE DETERMINATION OF BINARY GASEOUS DIFFUSIVITIES IN POROUS MATERIALS. Richard Paul Rhodes. Thesis, New York, Columbia Univ., 1962. 113p.

A number of processes used in industry today involve the transport of gases within micro-porous solids. Catalytic reactors, adsorption columns, and gaseous separation barriers are typical places in which these solids are utilized. Rates of transfer in the medium external to the solid have been fairly extensively examined. Relatively little work however, has been done on the transport of gases within the pores of the solid. A knowledge of the effect of temperature on this transport is even more limited. Previous workers have shown theoretically and experimentally that the efficiency of a heterogeneous catalyst is a function of the reaction rate and the diffusivity in the catalyst. It has further been shown that the evaluation of catalyst efficiency can be put on a much less empirical basis by use of the rate constant to effective diffusivity ratio. In the past the main difficulty with this method of prediction of catalyst efficiency was the lack of data on rate constants and diffusivities. The area for examination which was chosen in this study is the diffusion of ideal gases through several porous materials. The gases used in this investigation were almost all ideal in the sense of obeying additive volume laws, and of being used at temperatures far removed from their boiling points. The porous solids studied fall into two classes, beds of sim-

ple dense granular materials such as glass spheres and beds of high surface area catalyst materials such as alumina and silica gel. In general a statistical model was used in an attempt to present a physical picture of the diffusion process. Earlier work by other authors has indicated the possibility of a discrepancy existing between steady and unsteady state measurements. An attempt was made to resolve this question by making both steady and unsteady state measurements on the same material. The data obtained however, were insufficient to warrant extensive conclusions. In addition a non-volatile oil impregnation technique was developed which qualitatively shows the effect of pore size distribution on the transport through high surface area aluminas. (Dissertation Abstr., 23: No. 3, 1962)

2133 VISCOSITY OF MOLTEN LITHIUM-6 AND LITHIUM-7. Nguyen Tu Ban. Thesis, East Lansing, Michigan State Univ., 1960. 88p.

The viscosity of molten lithium-6 and lithium-7 was measured by observing the damping of a freely oscillating sphere filled with molten lithium. The viscosity coefficient was found by treating the damping of a slowly oscillating sphere containing a viscous fluid as a problem in the laminar flow of incompressible fluid. The temperature dependence of the viscosity of lithium-6 was found to be in general agreement with a law stating that the viscosity varies exponentially in the reciprocal of the absolute temperature. This law is also predicted by some existing theories of viscosity. The extrapolated value for the absolute viscosity of lithium-6 at the melting point (180.4°C) was found to be 4.50 mp. The effect of isotopic mass on viscosity was studied by measuring the viscosity coefficient of lithium-7 at a given temperature and comparing it with that for lithium-6 at the same temperature. The ratio of the viscosity of lithium-7 to that of lithium-6 at 236.8°C was found to be $(4.186 \pm 0.080/3.831 \pm 0.016) = 1.093 \pm 0.025$, in general agreement with the theoretical prediction that it is equal to the square root ratio of the atomic mass of lithium-7 to that of lithium-6, that is to $(7.018/6.017)^{1/2} = 1.080$. On the assumption that the viscosity coefficient for a mixture of isotopes of an element, consisting predominantly of one component, is a linear function of the number composition, the absolute viscosity of lithium-natural (92.5% lithium-7, 7.5% lithium-6) at 236.8°C is estimated to be 4.16 mp. This value is 24% lower than the corresponding value obtained by Andrade and Dobbs using lithium-natural. A detailed examination of their paper led to the conclusion that their values are significantly in error. (Dissertation Abstr., 23: No. 3, 1962)

2134 EXPERIMENTAL EVIDENCE FOR QUANTIZED MAGNETIC FLUX IN SUPERCONDUCTING CYLINDERS. Bascom Sine Deaver, Jr. Thesis, Stanford, N. J., Stanford Univ., 1962. 126p.

An experiment was motivated by a prediction of Fritz London in 1948 that the magnetic flux trapped by a persistent current in a superconducting loop is quantized in units of hc/e. The experiment demonstrated the existence of quantized flux in hollow tin cylinders but in units of $hc/2e = 2.07 \times 10^{-7}$ gauss-cm^2. A brief résumé of the London theory, particularly as it leads to the prediction of quantized flux, is presented. Also included are Onsager's comments on this prediction and his anticipation of the smaller unit. Measurements were made on two hollow tin cylinders about one centimeter long and 13-microns inside diameter with wall thicknesses of 1.5 and 5 microns. These were fabricated by electroplating tin onto a one centimeter length of No. 56 copper wire. To trap magnetic flux the cylinder was cooled below the superconducting transition temperature in the presence of a known applied axial field. The net flux in the cylinder was measured with the applied field on and after the field was turned off. The measurement was made by moving the cylinder up and down 100 times per second with an amplitude of one millimeter and observing the electrical pickup in two small coils, each of 10,000 turns, surrounding the ends of the cylinder. The system was calibrated by cooling the cylinder below the transition temperature in zero field and observing the emf produced when the completely diamagnetic cylinder was vibrated in a known applied field. From the measured cross sectional area of the cylinder and the value of the applied field, the flux corresponding to this signal was calculated. A total of about 250 data points are presented giving the following results: 1. The flux trapped in the cylinder both in the presence and absence of an applied magnetic field is not continuous but exhibits a step behavior, the first step occurring for $\Phi = hc/2e$, within experimental error in the data. Considering all sources of error, the value of the trapped flux at the first step is $hc/2e \pm 20\%$. 2. The data indicate additional steps at hc/e, 3hc/2e, and 2hc/e. 3. The ratios of the fields at which the steps occur are 1, 3, 5, and 7. 4. Since the time constant for the measuring apparatus was 22 seconds, the experiment gives only a large upper limit for the time involved in reaching the quantized values. Theoretical explanations and interpretations which have appeared since the publication of these results are summarized and discussed. These have been based on both the Bose gas model and the Bardeen, Cooper, Schrieffer theory. All relate the appearance of the factor of two in the flux unit to the occurrence of pairs of electrons in a super conductor and consider these results as direct proof of their existence. The states of the cylinder with trapped flux are regarded as metastable with the momenta of the pairs correlated over a macroscopic range (the circumference of the cylinder) and with the total angular momentum occurring in macroscopic units. Finally some new experiments to explore more precisely the nature of the persistent current states are described. (Dissertation Abstr., 23: No. 3, 1962)

2135 SUPERFLUID FLOW OF LIQUID HELIUM THROUGH NARROW CHANNELS AND THIN FILM. Hajime Seki. Thesis, Philadelphia, Univ. of Pennsylvania, 1961. 252p.

The flow property of liquid helium through extremely narrow channels and of the saturated helium film was investigated. Two mediums were used to provide narrow channels, porous vycor glass and Millipore filters. The interest in the porous vycor glass was the smallness of its pores. Though the geometry of the pores is complex the average pore diameter is fairly uniform and is of the order of 5×10^{-7} cm, which is order of magnitude small than the thickness of the saturated helium film. The physical characteristics of the Millipore filter are known to a relatively high degree of accuracy. The pores are essentially direct channels through the filter and are very evenly distributed over the filter area. The filters are available in various porosity grades ranging from 10^{-4} cm to 5×10^{-4} cm. With regard to the saturated helium film the anomalous behavior first reported by Eselson and Lasarew and the flow property of the film at very low pressure heads were the main object of investigation. A difference thermometer which could detect temperature difference down to about 10^{-6}°K was developed and used in the present work. This difference thermometer made possible a steady state method of measuring the pressure head dependence of pure superflow. The flow measurements through porous vycor and 0.01 Millipore filter showed the existence of an onset temperature lower than the bulk lambda point below which superflow becomes possi-

ble. The onset temperature is similar to that which is observed in unsaturated films in that it decreases with the pore size. Millipore flow measurements showed a limiting flow velocity where the velocity became independent of the pressure head. At low temperatures this limiting velocity increased as the pore size decreased and indicated a maximum of about 23 cm/sec between 10^{-4} cm and 5×10^{-4} cm pore size. The anomalous behavior of the film flow reported by Eselson and Lasarew was confirmed and further information such as the influence of time, rim height, and contamination was obtained. Steady-state measurements applied to the film flow indicated a noticeable pressure head dependence below 0.005 cm of liquid helium pressure. The flow rate dropped from the normally observed rate of about 8×10^{-5} cc/sec cm to 5×10^{-5} cc/sec-cm as the pressure head decreased. Within experimental accuracy which was less than 0.002 cm of liquid helium pressure, no pressure head was observed for flow rates less than this lower value. It is believed that this is the true critical flow rate below which there are no frictional forces. Measurements were also made on the film oscillation and on the product of the vaporization coefficient with the effective area of evaporation. (Dissertation Abstr., 23: No. 3, 1962)

2136 NUCLEAR MAGNETIC RESONANCE OF Xe-129 IN LIQUID AND SOLID NATURAL XENON. William Mao-Shung Yen. Thesis, St. Louis, Washington Univ., 1962. 102p.

The spin-spin relaxation time (T_2) was measured by pulsed NMR techniques in solid and liquid Xe-129 in natural xenon as a function of pressure and temperature. At a Larmor frequency of 10.5 Mc, T_2 ranges from ~1.5 to ~2 sec in the solid and ~6 to ~20 sec in the liquid. Results in general confirm the predictions of theory. No pressure dependence of T_2 was found in the solid in the pressure ranges under study. The values of T_2 show an exponential narrowing in the solid all the way up to the melting point and a distinct further narrowing at the melting point. The values of T_2 in the liquid are undoubtedly limited by impurities and should be taken only as the lower limit. A diamagnetic field shift was observed in going from the solid to the liquid; the magnitude of the shift was found to be ~0.5 gauss [$(\Delta H)/(H) \sim 0.005\%$]. No pressure dependence of the shift could be established in view of the poor accuracy of the measurements. Using relations developed by Kubo and Tomita, the equation of self diffusion of Xe-129 in solid xenon was found to be $D = 3.03 \exp - \{(17.40 \pm 0.051 \times 10^3)/(RT)\}$ cm^2-sec in the temperature range −160 to −130°C. The liquid self diffusion coefficient (D) of Xe-129 was also measured using the two-pulse technique. Measured values of the activation energy seem to agree with recent measurements using a Xe-133 tracer. There is a discrepancy in the pre-exponential D_0 of approximately a factor of 2; the origin of this discrepancy is not clear. (Dissertation Abstr., 23: No. 3, 1962)

2137 d-HYBRIDIZATION IN Pi BONDS. Ojars Juris Sovers. Thesis, Princeton, N. J., Princeton Univ., 1962. 104p.

The importance of d-hybridization in pi-bonded systems is investigated in two cases. First, a variational calculation is carried out for the $2p\pi_u$ state of the molecule H_2^+. Orbital exponents of both p and d orbitals, and the coefficients of the d orbitals in the molecular orbital are determined over a range of internuclear distances of 2 to 10 atomic units. A comparison is made between the energies and wave functions given by this method with those given by: 1. a variational calculation which uses only p atomic orbitals, and 2. the exact solution of the non-relativistic Schroedinger equation. It is found that the energies given by the present method are, at every internuclear distance, improved by at least 80% over those given by method 1. The wave functions given by the three methods of calculation are compared at an internuclear distance of 3 a.u. The improvement of the trial function by the inclusion of d orbitals is considerable. The ratio of the coefficients of the d orbitals to those of the p orbitals is found to be 0.15 at an internuclear distance approximately equal to the length of a conjugated carbon-carbon double bond. This suggest that d-type atomic orbitals also make sizeable contributions to the MO's of pi electrons in unsaturated hydrocarbon molecules. The symmetry analysis shows that, in all of the molecules studied, two of the five d orbitals and three of the seven f orbitals may hybridize with p orbitals in most of the pi molecular orbitals. Only d orbitals were included in the numerical calculations, however. In order to determine the coefficients of the d AO's in the pi molecular orbitals, a variational calculation was made for benzene, in which an approximate Hamiltonian was used for the pi electrons. Non-neighbor interactions were neglected, but subsequently proved to be important in the determination of the orbital exponents of the d orbitals by minimizing the energy. In order to retain simplicity in the calculation, this approach was abandoned and the Hückel treatment was followed. The Coulomb and exchange integrals involving d orbitals are estimated by combining physical considerations with calculations of one-electron integrals. Orbital exponents of the d orbitals are estimated on the basis of the maximum overlap criterion and the calculation on H_2^+. Classification of the MO's according to their symmetries reduces the size of the secular determinants considerably, but for most molecules these are still too large to be solved by hand, and were diagonalized by an IBM 650 computer. The molecular orbitals obtained in this manner are used to calculate quantities such as resonance energies, charge densities, bond orders, dipole moments, and hyperfine coupling constants for comparison with experiment and with the quantities given by the Hückel theory which includes only p orbitals. The definitions of charge densities and bond orders must be modified to include the contributions of d orbitals. The effects of d-hybridization do not, for the most part, greatly alter the interpretation of resonance energies and bond lengths given by the simple Hückel theory. There are, however, certain compounds for which inclusion of d orbitals leads one to expect effects which are not predicted by the Hückel theory: a. The simple Hückel theory predicts equal resonance stabilization for trans- and cis-butadiene. Inclusion of d-hybridization makes transbutadiene more stable than cis-butadiene by about 700 cal/mole. b. Simple Hückel theory predicts the square cyclobutadiene molecule to have no resonance stabilization. Inclusion of d-hybridization stabilizes it by about 6 kcal/mole. c. The simple Hückel theory predicts zero dipole moment for phenanthrene. Inclusion of d-hybridization gives a dipole moment of 0.17 debyes. d. Simple Hückel theory predicts zero spin densities at certain carbons in pyrene negative ion; d-hybridization produces small spin densities at these positions. The inclusion of d orbitals does not shed any light on the problem of the anomalous length of the central bond in naphthalene. The effect of d-hybridization in the interpretation of many of the properties of pi-bonded systems may prove to have an importance at least equal to that of other refinements of molecular orbital theories, such as configuration interaction. (Dissertation Abstr., 23: No. 3, 1962)

2138 THERMIONIC A-C GENERATION. C. L. Eisen and A. Schock (Republic Aviation Corp., Farmingdale, N. Y.). Preprint Paper No. CP 62-1160. New York,

American Institute of Electrical Engineers, 1962. 22p. $1.00.

A system for modulating the output of a thermionic generator and delivering a high-voltage alternating current to the load is presented. After optimizing the mode of operation, equations for the maximum conversion efficiency are derived. For a given anode work function and cathode temperature, it is shown that the maximum a-c efficiency is equal to approximately 70% of the corresponding d-c value. An illustrative example, including a proposed design for a transformer, is appended. (auth)

2139 THERMIONIC ENERGY CONVERTERS. E. F. Redden and A. E. Wallis (Aeronautical Systems Div., Wright-Patterson AFB, Ohio). Preprint Paper No. CP 62-1150. New York, American Institute of Electrical Engineers, 1962. 7p. $1.00.

The state-of-the-art for thermionic energy converters and the basic operating characteristics of various designs are reviewed. Problem areas in converter design are identified. Development trends are pointed out. It is concluded that extensive basic and applied research must be accomplished in thermionic technology and high temperature materials before practical application of thermionic energy converters can be possible. Discussions are presented without resort to highly technical details or complicated theoretical analysis. A comprehensive bibliography of pertinent literature is included. (auth)

Astrophysics and Cosmology

Refer also to abstracts 2067 and 2365.

2140 (AFCRL-62-270) SPACE AND PLANETARY ENVIRONMENTS. Air Force Surveys in Geophysics No. 139. Shea L. Valley, ed. (Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.). Jan. 1962. 220p. (AD-274652)

A survey of the most frequently requested information on natural environments outside the earth's atmosphere is presented. Topics covered include: interplanetary gas and magnetic fields, the terrestrial magnetic field, the external terrestrial gravity field, corpuscular radiation in the vicinity of earth, solar electromagnetic radiation, the lunar environment, planetary environments, and space environment of the solar system. (M.C.G.)

2141 (AFCRL-62-651) STANDARD ERRORS OF COSMIC RAY DATA CORRECTED FOR ATMOSPHERIC EFFECTS. Technical Note No. 10. E. Dyring and S. Lindgren (Uppsala Univ. Inst. of Physics). Jan. 1962. Contract AF61(514)-1312. 14p.

A formula is obtained for the standard error of cosmic ray data which was corrected for atmospheric effects. It is used to estimate standard errors of the nucleonic and meson components corrected by different methods. The relative standard error is found to decrease with increasing counting rate up to an approximate value of 10^6 counts per time interval if simultaneous meteorological measurements are available for each recording interval. Above that counting rate the relative standard error is essentially constant. (auth)

2142 (GCA(10-S)-61-68(Del.)) A STUDY OF THE INADVERTENT MODIFICATION OF THE EARTH'S UPPER ATMOSPHERE. (Geophysics Corp. of America, Bedford, Mass.). Mar. 7, 1961. 71p.

Data on the atmosphere, fuels and coolants, and artificial contamination experiments and missile trail observations are reviewed. It is concluded that there is a possibility of a world-wide change in the upper atmosphere caused by rocket programs. A theoretical program is suggested to evaluate the problem. (J.R.D.)

2143 KINETIC PROPERTIES OF INTERPLANETARY MATTER. E. N. Parker (Univ. of Chicago). Planetary and Space Sci., 9: 461-75(Aug. 1962).

Estimates of the kinetic and transport properties of the interplanetary medium are reviewed. It is pointed out that the effective mean free paths of interplanetary ions and electrons are effectively small compared to the scale of the system, either because of Coulomb collisions or dynamical instability of the gas. Numerical expressions are given for the mean free path for Coulomb collisions, electrical conductivity, thermal conductivity, viscosity, electromagnetic emission rates, recombination and ionization times, and charge-exchange cross sections. The magnetic Reynolds number of the solar wind proves to be large, the Reynolds number not very large, and the Prandtl number small. All stationary atoms and ions are swept out of the solar system by the solar wind. It is pointed out that the quiet-day cosmic-ray density in interplanetary space increases the speed of sound beyond the orbit of Earth, reaching 10^2 km/sec at 50 a.u. should the solar wind extend that far. Energetic particles from the sun have an effect that may be much larger. The abundance of heavy ions in the solar wind may be significantly below the solar abundance because of diffusion in the solar corona. (auth)

Cosmic Radiation

2144 (AFCRL-62-675) COSMIC RAY INTENSITY VARIATIONS DURING 1961. Technical (Scientific) Note No. 12. A. E. Sandstroem, E. Dyring, B. O. Groenkvist, and S. Lindgren (Uppsala Univ. Inst. of Physics). Mar. 31, 1962. Contract AF61(514)-1312. 38p.

Tables are presented of the first and second harmonics of the daily variation recorded during 1961 in Uppsala and Kiruna. The yearly mean daily variations are illustrated by clock diagrams. Only a few prominent Forbush decreases followed by cosmic-ray storms were recorded during 1961. Diagrams illustrate the intensity variations in per cent of a "normal" counting rate. Some solar flare effects during July 1960 are discussed. (auth)

2145 (JINR-E-1032) NEUTRINOS AND THE COSMIC RAY INTENSITY AT GREAT DEPTHS. B. Pontecorvo and A. E. Chudakov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1962. 4p.

An analysis was made of data on the intensity of cosmic rays at great depths. It was concluded that the energy density of high-energy neutrinos ($E_\nu \gtrsim 1$ Bev) in the universe is at least three orders of magnitude less than the total energy density of nucleons. It was found that the neutrino-nucleon scattering cross section is smaller than 10^{-34} cm^2. (auth)

2146 (NYO-2670) THE TRAJECTORIES OF COSMIC RAYS IN A HIGH DEGREE SIMULATION OF THE GEOMAGNETIC FIELD. Technical Report No. 77. K. G. McCracken, U. R. Rao, and M. A. Shea (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Aug. 1962. Contract [AT(30-1)-2098]. 93p.

An investigation is described in which complex simulations of the geomagnetic field are used to determine the asymptotic approach direction of cosmic rays arriving at the earth's surface. Included are an explanation of the

FORTRAN program, data on asymptotic direction, graphs concerning cosmic-ray trajectories, and variation coefficient tabulations. (J.R.D.)

2147 INTENSITY INCREASE OF DIFFERENCE COMPONENTS OF COSMIC RADIATION PRIOR TO THE MAGNETIC STORM OF MAY 11, 1959. B. Trumpy and T. Svanes. Arbok Univ. Bergen, Mat.-Nat. Ser., No. 8, 1-14(1961).

The cosmic-ray storm connected with the magnetic storm of May 11, 1959 was investigated on the basis of recordings from a number of stations spread over the globe. At several of these stations an increase of the radiation intensity was observed preceding the sudden commencement of the magnetic storm. Studies of this increase effect and its dependence on the longitude and latitude of the stations were given. The additional radiation preceding the commencement of the magnetic storm had a distinct anisotropy in that it was found only at the daylight face of the earth. The anisotropy of this augmentation effect was also shown by directional measurements of the hard component of cosmic rays. These measurements supported the assumption that the increase was caused by a reflection of cosmic-ray particles from the approaching face of the magnetized solar stream. (auth)

2148 INVESTIGATION ON THE RADIATION DANGERS TO FLIGHT CREWS AND PASSENGERS OF JET AIRCRAFT. III. MEASUREMENT OF THE RADIATION BURDEN FROM COSMIC RADIATION. O. C. Allkofer, E. Bagge, and J. Truemper (Institut für Reine and Angewandte Kernphysik, Kiel). Atomkernenergie, 7: 249-57(July–Aug. 1962). (In German)

With a plastic scintillator, the radiation absorption dose was measured on board a jet aircraft. The investigations were carried out on the North Atlantic Route and the Far East Route of Lufthansa. With respect to their characteristics of energy loss, the plastic scintillator and the human body are similar to each other. Thus the measurements may be used directly to judge the radiation hazard. The measurements took place in the region up to 38,000 feet and between latitudes of 3°N and 60°N. For the 38,000 feet level on the North Atlantic Route (50° to 60°N) a radiation absorption dose of 0.19 mrad/h was measured. At the geomagnetic equator the value is 1.8 times lower. (auth)

2149 ON THE ANGULAR RADIATION ANISOTROPY IN RADIATIVE EARTH BELT. A. I. Ershkovich and V. D. Pletnev (Inst. of Atmospheric Physics, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Geofiz., No. 10, 1441-5(Oct. 1962). (In Russian)

Angular distributions of charged particles in the outer radiation belt were studied. It is shown that the degree and character of particle angular distribution anisotropy are nonuniform in both space (with increasing distance from the earth) and time (at stationary and perturbed periods). Probabilities of unstable plasma appearance in the upper atmosphere, relative to the sharp anisotropy of electron angular distribution, are discussed. (tr-auth)

2150 MEASUREMENT OF THE INTENSITY OF CHARGED PARTICLES AFTER THE CHROMOSPHERIC ERUPTION 7 JULY 1958. E. V. Gorchakov and G. A. Bazilevskaya. Planetary and Space Sci., 9: 507-9(Aug. 1962). (Translated by O. Blunn from Iskusst. Sputniki Zemli, No. 8, p.84-6, 1961).

The radiation intensity in the outer radiation belt is measured from 7 to 10 July 1958, following the great chromospheric eruption on 7 July 1958. Intensity increases of as much as 10^{12} times the normal intensities are observed. (T.F.H.)

2151 STUDY OF NUCLEAR COMPONENT OF COSMIC RAYS IN THIRD SPACE VEHICLE. L. V. Kurnosova, L. A. Razorenov, and M. I. Fradkin. Planetary and Space Sci., 9: 511-12(Aug. 1962). (Translated by H. S. H. Massey from Iskusst. Sputniki Zemli, No. 8, p. 87, 1961).

Cosmic nuclei having proton numbers ≥ 2, ≥ 14 or 15, and ≥ 28 or 30 are counted on board a satellite, and give count rates of about 10.3, 0.9, and 0.13 counts per minute respectively. These count rates give, for the flux of particles having $Z \geq 28$ to 30, about 0.1 particles $\cdot$ $m^{-2} \cdot sec^{-1} \cdot steradian^{-1}$. (T.F.H.)

2152 DISCOVERY OF RADIATION ANOMALIES ABOVE THE SOUTH ATLANTIC AT HEIGHTS OF 310-340 km. L. V. Kurnosova, T. N. Kolobyanina, V. I. Logachev, L. A. Razorenov, I. A. Sirotkin, and M. I. Fradkin. Planetary and Space Sci., 9: 513-16(Aug. 1962). (Translated by H. S. H. Massey from Iskusst. Sputniki Zemli, No. 8, p.90, 1961).

Anomalously high counting rates are observed for the total cosmic radiation at satellite altitudes, in Aug., 1960. The counting system accepts electrons over 8 Mev, protons over 60 Mev, and all other particles having comparable ionizing power. The counting rates at all latitudes are slightly higher than can be expected from cosmic radiation alone. In two regions above the South Atlantic Ocean and one region above northern Russia, however, anomalously high rates as high as 70 times the normal counting rate are recorded. These regions appear to be fairly stationary. (T.F.H.)

2153 ON THE ANGULAR DISTRIBUTION FUNCTION OF TOTAL NUMBER OF PARTICLES NEAR CASCADE SHOWER AXIS. V. V. Guzhavin. Vestn. Mosk. Univ., Ser. III, No. 3, 63-5(May-June 1962). (In Russian)

An analytical expression was found for the angular distribution function of the total number of $E > 0$ particles near a cascade axis. (tr-auth)

2154 TRANSVERSE POLARIZATION OF COSMIC RAY μ-MESONS. V. S. Berezinskii (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 43: 927-21(Sept. 1962). (In Russian)

It is shown that cosmic ray μ mesons have a transverse polarization. The μ-meson transverse polarization at the instant of production is calculated for various angles and energies. The transverse polarization of μ mesons with a kinetic energy of 44 Mev at heights exceeding 3000 m above sea level is determined. (auth)

2155 ON THE ENERGY OF μ-MESONS IN COSMIC RAY μ-MESON BEAMS. Yu. N. Vavilov (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 43: 1009-11(Sept. 1962). (In Russian)

On basis of the experimental data on the intensity of μ-meson beams at various depths underground, it is demonstrated that the minimum mean μ-meson energy in the beams at sea level should be $\geq 10^{12}$ ev. (auth)

Criticality Studies

2156 (HW-SA-2750) CRITICALITY AND NUCLEAR SAFETY OF SLIGHTLY ENRICHED URANIUM. E. D. Clayton and C. L. Brown (General Electric Co., Hanford Atomic Products Operation, Richland, Wash.). Sept. 11, 1962. Contract AT(45-1)-1350. 40p.

Fissile materials must be handled in such manner as to prevent inadvertent criticality outside reactors. Criticality reviews are thus required in fuel element fabrication processes and reactor fuels reprocessing operations involving enriched U. Safe mass or volume limits can vary

widely subject to the the degree of moderation and homogeneity of the $U-H_2O$ systems under consideration. In connection with these criticality problems, mass and volume limits (bucklings) are discussed for slightly enriched U solutions, solid U rods, and tubes (hollow rods), including some comments on criticality problems in handling large billets. Factors affecting criticality are reviewed together with methods of criticality control for U with enrichment in the range 0.72 to 5%. (auth)

2157 (LAMS-2698(Rev.)) HAZARDS EVALUATION FOR THE LOS ALAMOS CRITICAL ASSEMBLY FACILITY. W. U. Geer, P. G. Koontz, J. D. Orndoff, and H. C. Paxton (Los Alamos Scientific Lab., N. Mex.). Apr. 1962. Contract W-7405-eng-36. 80p.

The safety of Pajarito critical assembly operations depends upon remote control and upon good practice as defined by operating regulations and experimental plans. Distance, in some cases supplemented by shielding, would protect personnel against an extreme accident generating 10^{19} fissions. (auth)

2158 (MND-C-2502) AN EXPERIMENTAL PROGRAM ON WATER-MODERATED ARRAYS OF URANIUM AND STAINLESS STEEL. L. Welshans (Martin Co. Nuclear Div., Baltimore). May 1962. Contract [AT(30-1)-243]. 134p.

An experimental study on critical arrays of water-moderated, flat-plate, laminated fuel bundles is described. The U loading per bundle was about 54 g U^{235}; stainless steel and boron steel contents were varied to provide the desired metal-to-water ratio and the proper boron loading. The experiments were performed in support of the ANPP code development program. This program is aimed at development of an automated general prupose nuclear design code. A total of 12 cores were studied. (J.R.D.)

2159 (UCRL-6980) HIGH-TEMPERATURE BARE BeO CRITICAL EXPERIMENTS: GENERAL DESCRIPTION AND PRELIMINARY RESULTS. Reinald G. Finke (California. Univ., Livermore. Lawrence Radiation Lab.). June 29, 1962. Contract W-7405-eng-48. 23p.

Five high-temperature bare BeO critical experiments were conducted for three different gross BeO/U^{235} molar ratios: 280:1, 550:1, and 1100:1. For each ratio, at least two critical configurations were determined. Their corresponding critical temperatures ranged up to 1115°F. The buckling temperature coefficient at 500°F varies directly with BeO/U^{235} ratio from 0.26%/100°F for the lower ratio to 0.60%/100°F for the higher ratio. The contribution of thermal expansion to the buckling temperature coefficient was examined for different BeO-block arrangements in the graphite supporting box. A variation by a factor of three for different block positions is calculated. Within experimental error, the nuclear components of the BeO buckling temperature coefficients are the same as, and show the same dependence on moderator-to-uranium ratio as, those previously reported for graphite at C/U^{235} ratios about 2.3 times the BeO/U^{235} ratios. (auth)

Elementary Particles and Radiations

2160 (IS-506) LARGE ANGLE PAIR PRODUCTION. James David Plimpton and Charles L. Hammer (Ames Lab., Ames, Iowa). Aug. 1961. Contract W-7405-eng-82. 137p.

Work to experimentally verify one of the predictions of quantum electrodynamics in the medium relativistic range is reported. This theory treats the interaction between charged particles and radiation fields. Approximate calculations were made and experimentally verified for cases in which the particles concerned have either a very high or a very low energy; but the approximations fail to hold in the middle region (energies of the order of m_0c^2). Accordingly, an investigation is made of the low-energy positrons created by high-energy photons in the Coulomb field of a nucleus (pair production). The theory predicts the occurrence of a peak at approximately $\frac{1}{2}\ m_0c^2$ in the energy spectrum of positrons emitted at large angles to the incident photon direction. The experiment was conducted to find this effect as well as the absolute cross section for the process, its dependence upon the Z of the nucleus, and the energy of the incoming photon. The results of the experiment are in agreement with the predictions of the Born approximation as to the "position" of the peak and as to the dependence of the cross section on Z and the photon energy. However, the magnitude of the measured cross section is at least 12 times larger than the predictions of the Born approximation calculation. (auth)

2161 (JINR-P-1014) O VOZMOZHNOSTI NAKOPLENIYA OPTICHESKIKH NEITRINO V ZAMKNUTYKH POLOSTYAKH. (On the Possibility of Accumulating Optical Neutrinos in Closed Cavities). V. B. Belyaev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 6p.

An analysis was made of neutrino wave properties (the phenomenon of intrinsic reflection). In the case of a neutrino beam incidence from a dense medium to a less dense boundary, a total intrinsic neutrino beam reflection initiates at an arbitrary angle a with cos a 1/n (n is diffraction coefficient). Thus, in a closed spherical or elliptical β-active surface all neutrinos incident at a or less should undergo a total intrinsic reflection and collect on the thin surface layer. The mechanisms knocking neutrinos out of the accumulation process are analyzed. (R.V.J.)

2162 (JINR-P-1018) MODEL SKALYARNOI TEORII POLYA V KVANTOVANNOM PROSTRANSTVE VREMENI. (A Model of the Scalar Field Theory in the Quantized Space Time). V. G. Kardyshevskii (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 11p.

A simple scalar model was used in an investigation of generalized quantum field theory in quantum space-time formalism. In the new scheme the x^n coordinates are noncommuting operators and all construction is accomplished in p-space, which in the given case is a constant space curvature. The 4-space p_m(m = 0, 1, 2, and 3) is resolved when $\epsilon = 1$. The shift transformation coordinate in p-curvature the x^n operator, and the volume element $d\Omega_p$ are defined and developed. (R.V.J.)

2163 (JINR-P-1043) DISPERSIONNYE SOOTNOSHENIYA I ANALITICHESKIE SVOISTVA PARTSIAL'NYKH AMPLITUD V TEORII VOZMUSHCHENII. (Dispersion Relations and Analytical Properties of Partial Amplitudes in the Perturbation Theory). A. A. Logunov, I-chên Liu, I. T. Todorov, and N. A. Chernikov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 32p.

Analytical studies are made of π meson and nucleon elastic scattering amplitudes in perturbation theory. Dispersion relations were derived for fixed $\underline{t}$ (or $\underline{S}$) and for fixed cos θ. Dispersion relations for partial nucleon-nucleon and meson-meson scattering amplitudes were developed using dispersion relations at fixed cos θ. The

analytical properties of partial amplitudes in meson scattering on nucleons were also studied. (tr-auth)

2164 (JINR-P-1047) OB OPREDELENII SPINA K*. (On the Determination of K* Spin). S. M. Bilen'kii and R. M. Ryndin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 4p.

The process of $\overline{K}$, K*, or K,$\overline{K}$* pair production by collisions of incoming electron-positron beams was used for determining the K* (zero or unity) spin observations of K meson (charged or uncharged) spectral peaks at the pair creation point indicated that the K* spin is 1. (R.V.J.)

2165 (JINR-P-1056) VZAIMODEISTVIE π^--MEZONOV S VODORODOM PRI ENERGII 340 Mev. (Interactions of π^- Mesons with Hydrogen at 340 Mev). T. D. Blokhintseva, V. G. Grebinnik, V. A. Zhukov, G. Libman, L. Nemenov, G. I. Selevanov, and Jung-fang Yün (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1962. 28p.

A 25-cm liquid hydrogen bubble chamber placed in a magnetic field was used in studies of $\pi^- + p \rightarrow \pi^- + \pi^+ + n^+ + n$, $\pi^- + p \rightarrow \pi^- + \pi^0 + p$, and $\pi^- + p \rightarrow \pi^- + \gamma + p$ reactions at a π^- energy of 340 ± 15 Mev. Measurements of the total cross sections showed that π meson interactions at scattering length T = 0 is considerably stronger than at T = 2. The angular distributions of secondary particles and the distributions at total center-of-mass energy for π^+ n, π^- n, and $\pi^+ \pi^-$ were found. (tr-auth)

2166 (JINR-P-1060) INTEGRAL'NOE PREDSTAVLENIE VERSHINNOI CHASTI V TEORII VOZMUSHCHENII. (Integral Concept of the Vertex in the Theory of Perturbation). I-chên Lin and I. T. Todorov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 7p.

A spectral concept of the vertex in perturbation theory was derived using two variables proposed by S. Deser et al. (Phys. Rev., 115: 731, 1959) and an ordinary one-dimensional dispersion relation in arbitrary order of the theory. The developed integral concept of nucleon-nucleon scattering amplitudes was analogous to the results obtained for the vertex concept. (R.V.J.)

2167 (NP-12195) THREE-BODY LEPTONIC DECAY MODES OF K-MESONS. Technical Report No. 43. J. D. Jackson and R. L. Schult (Illinois. Univ., Urbana). Oct. 1962. Contract ONR-1834(05). 15p.

Data on the decay modes of K_{e3} and $K_{\mu3}$ are reviewed, pointing out those models excluded by the data and those which could be tested with additional experimental investigation. Spin and isospin symmetries of the matrix element and dynamics of the interaction as shown by form factors are reported. Data on the spectra for the K_{e3} mode of K^+ mesons and K_2^0 mesons are consistent with a vector interaction and form factors which are relatively slowly varying functions of pion energy. The isospin structure of the K_{e3} modes is inconsistent with the $\Delta T = \frac{1}{2}$ rule and the two-spurion model. If the electron mass is neglected, only one factor is involved. For the $K_{\mu3}$ modes, two form factors appear. The relative values of these form factors influence the energy spectra and the $K_{\mu3}/K_{e3}$ ratio. (N.W.R.)

2168 (TID-17205) EFFECTS OF REGGE POLES ON THE POLARIZATION IN HIGH ENERGY NUCLEON-NUCLEON SCATTERING. Ivan J. Muzinich (Washington. Univ., Seattle). Oct. 1, 1962. Contract AT(45-1)-1388. 6p.

In N-$\overline{N}$ scattering it is shown that the polarization decreases with a power of the energy; the power is determined by the Pomeranchuk Regge trajectory and the Regge trajectory with the quantum numbers of the N-$\overline{N}$ channel that lies closest to the Pomeranchuk Regge trajectory. The polarization in N-$\overline{N}$ scattering is related to five independent helicity amplitudes. Equations were derived. (M.C.G.)

2169 (UCRL-10187) NEUTRAL PIONS FROM PROTON-PROTON COLLISIONS AT 735 Mev (thesis). Gilbert D. Mead (California. Univ., Berkeley. Lawrence Radiation Lab.). May 8, 1962. 85p.

An investigation was made of the reaction $p + p \rightarrow p + p + \pi^0$ at an incident proton energy of 735 Mev. The external proton beam of the 184-in. synchrocyclotron bombarded a liquid hydrogen target. Gamma spectra were measured at lab angles of 6, 32, and 60 deg with respect to the proton beam. Two high-resolution pair spectrometers were used to analyze the photons. Computer codes were used to make all necessary corrections to the data and determine the final spectra. No evidence was found for gamma rays produced from any source other than π^0 decay. The cross section for π^0 production was measured to be 3.46 ± 0.25 mb. Using a least-squares analysis, angular and momentum distributions for the neutral pion in the two-proton c.m. system were determined from the photon spectra. The pion angular distribution is given by $d\sigma_{\pi^0}/d\Omega = \sigma_{tot}/4\pi\,[0.834 + 0.099 (3\cos^2\theta) + 0.067 (5\cos^4\theta)]$. That is, 83% of the pions are produced with isotropic distribution. This result is consistent with the isobar model of pion production. Pion momentum distributions are given for several c.m. angles. These also support the isobar model. (auth)

2170 (UCRL-10205) EXPERIMENTAL STUDY OF THE $K^+_{\mu3}$ AND K^+_{e3} DECAY MODES OF THE K^+ MESON. John L. Brown, John A. Kadyk, George H. Trilling, Remy T. Van de Walle (California. Univ., Berkeley. Lawrence Radiation Lab.; California. Univ., Berkeley); Byron P. Roe, and Daniel Sinclair (Michigan. Univ., Ann Arbor). Aug. 20, 1962. Contract W-7405-eng-48. 55p.

To investigate the nature of strangeness-nonconserving weak interactions, samples of 76 $K^+_{\mu3}$ ($K^+ \rightarrow \mu^+ + \pi^0 + \nu$) and 216 K^+_{e3} ($K^+ \rightarrow e^+ + \pi^0 + \nu$) decays at rest observed in a xenon bubble chamber were examined. The combined data indicated that the V-A theory correctly describes K^+_{e3} and $K^+_{\mu3}$ decay; the μ^+ and e^+ are coupled with the same strength in three-body leptonic K^+ decay; and the magnitude and energy variation of the form factors involved are consistent with predictions based on the partially conserved current hypothesis. (auth)

2171 (AEC-tr-5465) SCATTERING OF FAST ELECTRONS. P. Urban and H. Zingl. Translated for Los Alamos Scientific Lab., N. Mex. from Fortschr. Physik, 7: 641-74(1959). 36p.

A review of information on scattering of fast electrons is presented. Theoretical and experimental aspects of elastic and inelastic scattering are presented along with similar information concerning scattering by protons, deuterons, and neutrons. (J.R.D.)

2172 REMARK CONCERNING THE EIGENVALUES OF ORBITAL ANGULAR MOMENTUM. H. A. Buchdahl (Univ. of Tasmania, Hobart, Australia). Am. J. Phys., 30: 829-31(Nov. 1962).

It is shown in an elementary manner that the eigenvalues of the components of orbital angular momentum are integral, any explicit appeal to single-valuedness being avoided. (auth)

2173 INTERACTION OF 2 Gev NEGATIVE π-MESONS WITH EMULSION NUCLEI. B. E. Ronne and O. Danielsson (Univ. of Stockholm). Arkiv Fysik, 22: 175-91(1962). (In English)

An investigation of 281 interactions of 2-Bev/c negative pions with emulsion nuclei is reported. The fraction of stars with charged secondary pions is 75 ± 3 per cent, and the mean number per star of emitted charged pions is 1.21 ± 0.08. Only 2 K mesons are observed, which result confirms that the production cross section of strange particles is low. The results are compared with the predictions from a cascade calculation that starts from the known elementary pion-nucleon and nucleon-nucleon cross sections. The agreement between the calculated data and the experimental results is good as far as the multiplicity, energy spectrum, and angular distribution of emitted pions and the energy spectrum of knock-on protons are concerned. (auth)

2174 THEORY OF ELEMENTARY PARTICLES. Pierre Hillion (Institut Henri Poincaré, Paris). Cahiers Phys., 16: 195-217(May 1962). (In French)

A field theory is presented for elementary particle properties. The isobaric spin, strangeness, baryon number, and charge are taken into account. The theory yields the classification of Nishijima and Gell-Mann, as well as the σ meson. Given the Lagrangians of strong, weak, and electromagnetic interactions, the theory also yields conservation and selection laws that are in accord with experiment. The theory explains certain experimentally observed resonances. (T.F.H.)

2175 GENERAL STUDY OF THE RELAXATION OF A SYSTEM OF PARTICLES. J. Salmon (Faculté des Sciences, Caen, France). J. Phys. Radium, 23: 363-70(June 1962). (In French)

The hypotheses which enable one to establish the Vlassov and Fokker-Planck equations from the B. B. G. K. Y. equation are analyzed. The difficulties to which these equations lead when the problem of return to equilibrium is examined are indicated. A method called "method of variations" to remove these difficulties is proposed. (auth)

2176 STUDY AND QUANTIZATION OF A PENTA-DIMENSIONAL UNITARY THEORY. S. Lederer (Institut Henri-Poincaré, Paris). J. Phys. Radium, 23: 381-5(June 1962). (In French)

Equations are synthesized for a spin-2 particle in a five-dimensional space (V_5); so as to have a single set. The synthesis is accounted for in the linear approximation of the Jordan-Thirty field. The five-dimensional field is quantized by the A. Lichnerowicz method. (tr-auth)

2177 DISPERSION ANALYSIS OF Ξ PRODUCTION IN $\overline{K}N$ COLLISIONS. Alladi Ramakrishnan, R. Thunga, T. K. Radha, G. Bhamathi, and S. Indumathi (Inst. of Mathematical Sciences, Madras). Nucl. Phys., 37: 585-93(Sept. 1962). (In English)

An analysis by dispersion theory of the production process $\overline{K} + N \rightarrow \Xi + K$ is given for different combinations of the relative parities of the strange particles involved. Solutions are given for partial wave amplitudes under reasonable approximations. Graphs for differential cross sections for $P(\Xi N) = +1$ and $P(YN) = -1$ are presented. (auth)

2178 DISPERSION RELATIONS FOR THE PHOTO-DISINTEGRATION OF THE DEUTERON. A. Donnachie (Glasgow Univ.). Nucl. Phys., 37: 594-623(Sept. 1962). (In English)

The calculation of the matrix element for deuteron photo-disintegration is considered. There are twelve invariant amplitudes. The covariant form of the transition amplitude is related to the non-covariant (Pauli-matrix) form, which is further related to the individual multipole transition amplitudes. The Born terms of the covariant amplitudes are derived, and the dispersion relations written down in energy for a fixed difference in the photon-proton and photon-neutron momentum transfers. It is necessary to use this form rather than a fixed momentum transfer, in order to exhibit explicitly all the poles in the dispersion relations. The dispersion relations are restricted to dipole and quadrupole transitions, and by considering the relations at two different momentum transfers, equations are obtained explicitly for the individual electric dipole and magnetic dipole spin-flip transition amplitudes. The equations are solved in a low-energy approximation, in which the final n-p state rescattering cut and single-pion exchange cut only are considered, for the two cases of Gammel-Thaler and Signell-Marshak phase shifts. The results obtained are compared with experiment. (auth)

2179 ON THE CALCULATION OF THE PHASE SHIFTS IN NUCLEON-NUCLEON SCATTERING WITH SPIN-ORBIT INTERACTION. T. Gajewski (Univ. of Łódź, Poland). Nucl. Phys., 37: 679-88(Sept. 1962). (In English)

A method of calculating the phase shifts for a Yukawa potential with spin-orbit interaction is developed. Formulas for phase shifts are obtained that are generalizations of those for the case of scattering in a static field without spin-orbit coupling. (auth)

2180 RADIATIVE CORRECTIONS TO WEAK INTERACTIONS. D. B. Pearson and J. C. Taylor (Cambridge Univ., Eng.). Nucl. Phys., 37: 689-90(Sept. 1962). (In English)

It is proposed to use the freedom allowed by gauge invariance to clear up certain ambiguities connected with divergent integrals and nucleon-structure-dependent integrals that are encountered in the electrodynamics of weak interactions. (auth)

2181 RADIATION OF AN EXTENDED SOURCE. M. J. Barrett (Allis-Chalmers Mfg. Co., Washington, D. C.). Nucl. Sci. Eng., 14: 186-91(Oct. 1962).

The gamma current intensity (flux) and the gamma emission (leakage) of a homogeneous, spherical medium are derived by inserting a source spectrum in the Boltzmann transport equation. In the range of photon energies from 0.5 to 10.5 Mev, Compton scattering by electrons of the medium dominates the energy degradation of photons, so that one may use Klein-Nishina cross sections for the transfer kernel. Lumping the flux into energy groups permits an approximation of the transport equation as a matrix equation. Numerical solutions for the flux and leakage spectra, found by inverting the matrix equation, agree well with the results of previous theoretical studies. (auth)

2182 PENETRATION AND DIFFUSION OF A BEAM OF RADIATION. William R. Faust and Arlo D. Anderson (Naval Research Lab., Washington, D. C.). Nuclear Sci. and Eng., 14: 17-21(Sept. 1962).

An approximate solution is obtained to the three-dimensional equation of transport for a point source radiating along the Z-axis. The radiation is separated into scattered and unscattered components, and the transport equation for the scattered radiation is derived. The appropriate solution for the scattered radiation is obtained by expanding the intensity in tesseral harmonics and solving the resulting equations for the amplitude of each harmonic. Some numerical results are presented to illustrate the behavior of the solution at great depths of penetration. (auth)

2183 RELATIVISTIC QUANTUM THEORY OF PARTICLES WITH VARIABLE MASS. [PART] II. H. C. Corben (Space Technology Labs., Inc., Redondo Beach, Calif.). Proc. Natl. Acad. Sci. U. S., 48: 1746-52(Oct. 1962).

The following wave equation offers a new method for de-

scribing a free particle in relativistic quantum theory: $(i\epsilon_l p_l + Mc)\psi = 0$. Where M is the operator: $M = m + m_0\epsilon_{kl}\eta_{kl} + m'\epsilon_k\eta_k$. The special case of equation two is considered for which $m' = 0$, and in which m and m_0 are arbitrary c-number parameters. Four generalizations of the Dirac and Kemmer-Duffin equations are considered. The spin-zero and spin-one states of bosons and the rest-system of fermions are analyzed mathematically. (C.H.)

2184 A DETERMINATION OF THE GYROMAGNETIC RATIO OF THE PROTON. P. Vigoureux (National Physical Lab., Teddington, Middx., Eng.). Proc. Roy. Soc. (London), Ser. A, 270: 72-89(Oct. 30, 1962).

The gyromagnetic ratio of the proton is measured by observing the precessional frequency of the protons of a sphere of water in a field of 10 to 20 Oe. The result, uncorrected for diamagnetism, is 26751.71 emu(cgs), referred to the unit of electric current maintained by standard resistances and standard cells. The 50% or 'probable' systematic error is estimated to be 2 in 10^6 and the interquartile range of 40 observations is 3 in 10^6. (auth)

2185 PARTICLE INTERACTIONS IN NON-LINEAR ELECTRODYNAMICS. V. N. Linkin and N. N. Kolesnikov. Vestn. Mosk. Univ., Ser. III, No. 3, 17-26(May-June 1962). (In Russian)

Studies of particle interactions in general non-linear electrodynamics show that interactions between point and extended particles approximately coincide with interactions of two particles with extended charges and with magnetic moments in the linear theory. (tr-auth)

2186 GEOMETRY OF CHARGED PARTICLE MOTIONS. Yu. P. Pyt'ev. Vestn. Mosk. Univ., Ser. III, No. 3, 30-40(May-June 1962). (In Russian)

The geometric properties of charged particle motion in electromagnetic fields were analyzed. (tr-auth)

2187 THE QUANTUM-FIELD ANALYSIS OF MULTIPLE PROCESSES. B. T. Vavilov, I. A. Verdiev, N. G. Goncharov, V. I. Grigor'ev, and G. V. Meledin. Vestn. Mosk. Univ., Ser. III, No. 3, 46-58(May-June 1962). (In Russian)

A quantum-field analysis was made of multiple π-meson production in π-N, γ-N, N-N, and π-π interactions. Formulas were derived for multiplicities and angular and energy distributions. The calculations are in good agreement with experimental data. (tr-auth)

2188 THE AXIOMATICS OF THE DIRAC γ OPERATORS IN RIEMANN SPACE. Ernst Schmutzer (Universität Jena, Ger.). Z. Naturforsch., 17a: 685-92(Aug. 1962). (In German)

While usually $\gamma^\nu\gamma^\mu + \gamma^\mu\gamma^\nu = 2\,g^{\mu\nu}$ is considered as the fundamental relation for the definition of Dirac's γ operators in curved space in our axiomatic foundation this relation is a derived one being deduced from the fundamental axiom. Starting from this axiom the γ algebra in curved space is developed. The choice of hermitean γ operators in curved space is investigated. The fundamental problem of splitting the γ-operators into Pauli's σ-operators, i.e., with the problem of the connection of bispinor and spinor formalism, is then considered. All computations are based on general curved coordinates fully avoiding the tedious orthogonal Vierbein-formalism. (auth)

2189 THE THEORY OF ELECTRONS. VI. FOUR-VELOCITY AND SELF-ACCELERATION. Walter Wessel (Universität, Heidelberg, Ger.). Z. Physik, 169: 1-16 (1962). (In German)

A disagreement concerning behavior in space inversion is attached to the mass operator derived in preceding work. It was shown that it can be accurately eliminated when a still existing degree of freedom in the determination of two four-vectors is considered. In place of the s_k, t_k previously used as an auxiliary, the real or pseudo four-velocity U_k and u_k with which this theory is confirmed is used. Representations of U_k and u_k and the spectra of their four components were derived and discussed in connection with the so-called run-away solutions. (tr-auth)

2190 MEASUREMENT OF THE RATIOS OF THE SPIN RESONANCE FREQUENCY OF PROTONS AND THE CYCLOTRON FREQUENCY OF FREE ELECTRONS IN EQUAL MAGNETIC FIELDS. R. Honerjaeger and E. Klein (Freie Universität, Berlin). Z. Physik, 169: 32-44(1962). (In German)

The behavior of the spin resonance frequency ω'_p of protons in a 0.06 molar solution of $FeCl_3$ in water and the cyclotron frequency ω_z of free electrons in equal magnetic fields (≈3300 gauss) were measured. The cyclotron resonance was observed on electrons of the space charge cloud of a glowing cathode; an especially narrow line with a relative width of 3×10^{-5} was obtained. As a preliminary result $\omega'_p/\omega_z = 1.52096_8 \times 10^{-3} \pm 26 \times 10^{-8}$ was measured. The relatively high field inhomogeneity and the skill inadequate transient field constant limit the accuracy of the results. (tr-auth)

2191 ANGULAR DISTRIBUTION OF DECAY PRODUCTS OF λ-HYPERONS PRODUCED BY 2.8 Bev/c π^--MESONS ON XENON NUCLEI. I. A. Ivanovskaya, E. B. Kuznetsov, A. Prokesh, and I. V. Chuvilo (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR and Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 43: 765-74(Sept. 1962). (In Russian)

The asymmetry coefficients of the angular distribution of the decay products of Λ hyperons produced by 2.8-Bev/c π^- mesons on xenon nuclei are measured relative to the plane of production of the Λ particles (up–down asymmetry) and to two planes perpendicular to this plane: (a) a plane perpendicular to the direction of flight of the Λ particles in the laboratory system (forward–backward asymmetry) and (b) a plane passing through the direction of flight of the Λ particle (right–left asymmetry). Only decays of the $\Lambda \to \pi^- + P$ types were used in constructing the distributions. The up–down asymmetry for Λ particles with momenta in the laboratory system between 400 and 900 Mev is characterized by the quantity $\alpha\bar{P}_2 = -0.27 \pm 0.12$ (in the right hand coordinate system); the forward–backward asymmetry is $\alpha\bar{P}_2 = +0.27 \pm 0.13$ and for the right–left asymmetry $\alpha\bar{P}_3 = +0.26 \pm 0.12$. All three coefficients have been determined from the angular distribution of decay π mesons in the rest system of the Λ hyperon. Possible systematic errors in determining the magnitude of $\alpha\bar{P}_2$ are discussed. (auth)

2192 A RARE CASE OF A HIGH ENERGY NUCLEAR INTERACTION WITH AN ISOTROPIC ANGULAR DISTRIBUTION OF THE SECONDARY PARTICLES. K. I. Alekseeva, L. L. Gabuniya, Peng-Su Teng, G. B. Zhdanov, and M. I. Tretyakova (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 43: 783-9(Sept. 1962). (In Russian)

An interaction in a photographic emulsion of the type $2 + 3 + 40$ p with an isotropic angular distribution of the particles in a certain coordinate system (with a Lorentz factor $\gamma_c = 65$) is considered. The event is compared with others possessing close values of the numbers of secondary relativistic particles n_s and of γ_c. Under the usual assumption regarding the mean value of the transverse momentum, the effective mass of the target is determined and found to be close to the π-meson mass. (auth)

2193 A STUDY OF ΛK^0 AND $K^0\overline{K}^0$ PAIR PRODUCTION IN THE INTERACTION BETWEEN 7-8 Bev/c π^--MESONS AND PROTONS. Yung-chang Wang, V. I. Veksler, Yuan-tsai Tu, E. N. Kladnitskaya, A. A. Kuznetsov, A. Mihul, Ting-tu Nguyen, V. N. Penev, E. S. Sokolova, and M. I. Solovev (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 43: 815-22(Sept. 1962). (In Russian)

ΛK^0 and $K^0\overline{K}^0$ pair production in π^-p interactions is studied for π-meson momenta of 7 to 8 Bev/c. The angular and momentum characteristics of the Λ and K^0 particles (in the π^-p cms) from the ΛK^0 and $K^0\overline{K}^0$ pairs and also the angular and momentum distributions of π^+ mesons accompanying ΛK^0 pair production are presented. Data on the magnitude of Q for the investigated pairs are also presented. (auth)

2194 A MODEL OF UNIVERSAL WEAK INTERACTION. E. M. Lipmanov (Volgogradsk Pedagogical Inst., USSR). Zh. Eksperim. i Teor. Fiz., 43: 893-9(Sept. 1962). (In Russian)

On basis of a number of initial assumptions a model of weak interactions is constructed in which particles not involved in strong interactions (intermediate bosons and leptons) possess "shison" properties in the Lee and Yang sense of the word. The possibility of an experimental detection of new heavy charged leptons predicted by the model is discussed. (auth)

2195 ANOMALOUS THRESHOLDS AND INTERACTION IN THE FINAL STATE. V. V. Anisovich, A. A. Anselm, V. N. Gribov, and I. T. Dyatlov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 43: 906-8(Sept. 1962). (In Russian)

The effect of anomalous singularities on the three particle production amplitude near the threshold is investigated. (auth)

2196 THE TOMONAGA-SCHWINGER EQUATION IN THE BOGOLYUBOV METHOD. A. D. Sukhanov (Inst. of Mathematics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 43: 932-41(Sept. 1962). (In Russian)

A consistent deduction of the Tomonaga-Schwinger equation of the classical type is performed within the framework of the Bogolyubov method. An expression for the local interaction Hamiltonian in any renormalized theory is derived by taking into account the symmetry properties of the quasilocal operators. The problem of surface divergences is found to arise only for diagrams of the boson self-energy. However, the question of removing them remains open. (auth)

2197 μ^+-MOLECULES. A. A. Anselm and V. M. Shekhter (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 43: 958-62(Sept. 1962). (In Russian)

Molecules or ions consisting of ordinary atoms and muonium or a μ^+ meson are considered. Such μ^+ molecules can be produced when μ^+ mesons are slowed down in matter, and in many respects they resemble molecules in which a hydrogen atom is located at the corresponding site. The vibrational and rotational spectra of such molecules differ from those of ordinary molecules. The probability of a system consisting of muonium and a hydrogen atom being formed upon the slowing down of μ^+ mesons in hydrogen gas is calculated. It strongly depends on the gas temperature. Up to 800°K practically no molecules are produced whereas above this temperature almost all μ^+ mesons yield molecules. Some other reactions are discussed, and the possibility of experimental observation of the μ^+ molecules is discussed. (auth)

2198 A MORE EXACT DETERMINATION OF PARAMETERS OF THE EFFECTIVE RADIUS THEORY BY USING THE MANDELSTAM DISPERSION RELATIONS. V. I. Lendel, Yu. M. Lomsadze, and B. M. Ernst (Uzhgorodsk State Univ., USSR). Zh. Eksperim. i Teor. Fiz., 43: 974-6(Sept. 1962). (In Russian)

A systematic extrapolation to the pole of the experimental data on the low-energy p-p scattering distribution is performed on the basis of the Mandelstam representation, and in this way the coupling constant $f^2 = 0.058$ is obtained. It is also concluded that a Yukawa type potential is predominant in the low energy p-p interaction. (auth)

2199 INVESTIGATION OF ELASTIC SCATTERING OF NEUTRINO OR ANTINEUTRINO ON ELECTRONS BY TAKING INTO ACCOUNT HIGHER APPROXIMATIONS. Van-hieu Nguyen (Moscow Inst. of Physics Engineering). Zh. Eksperim. i Teor. Fiz., 43: 984-90(Sept. 1962). (In Russian)

With help of the dispersion relation elastic scattering of the neutrino or antineutrino on electrons is analyzed by taking into account only the $(1 + \gamma_5)$ invariant interaction of the (νe) $(e\nu)$ type. The Low integral equation whose solution depends on two constants is derived in the two-particle approximation from the dispersion relations and unitarity condition. One of the constants is defined by the universal weak interaction constant. The result obtained indicates that in the approximation under consideration a resonance exists whose position and half-width depends on an unknown constant. When the energy tends to infinity, the cross section for the processes under consideration approaches zero. (auth)

2200 ANNIHILATION OF POSITRONS IN AN IONIZED GAS. I. N. Toptygin (Leningrad Polytechnic Inst.). Zh. Eksperim. i Teor. Fiz., 43: 1031-6(Sept. 1962). (In Russian)

The lifetime of positrons in ionized hydrogen and the shape of the annihilation line are determined. It is shown that in a broad temperature range Coulomb correlations play an important role. (auth)

2201 THE MAGNETIC DIPOLE DISINTEGRATION OF THE DEUTERON. Gerald Alvin Peterson. Thesis, Stanford, Calif., Stanford Univ., 1962. 116p.

The magnetic dipole disintegration of the deuteron was measured for excitation energies up to 16 Mev in the presence of relatively small electric multipole contributions by using a new method of inelastic electron scattering in the far backward direction. Scattering at 180° gave the maximum suppression of electric multipole transitions with respect to the magnetic dipole transition, and it had the added advantage that elastic charge scattering was minimized. Thus the background electron spectrum resulting from elastic scattering accompanied by radiation was greatly reduced. The method consisted of deflecting a beam of 41.5-Mev in a magnetic field just before it struck the target. Electrons scattered into the solid angle at 180° were deflected in the same magnetic field into a magnetic spectrometer set at 160° with respect to the incident beam. The inelastic electron scattering data for the deuteron were compared to elastic electron-proton scattering data in order to obtain experimental electrodisintegration cross sections. The theoretical electron-proton scattering cross section of Rosenbluth, modified by form factors, was assumed to be valid. The experimental results were compared to the deuteron electrodisintegration theory of Jankus. The experimental points with large probable errors are higher than theory by about 5 percent for low excitation energies and increase to 28 percent for a 16 Mev excitation energy. The

discrepancies may result from the neglect of exchange currents in the theory. (Dissertation Abstr., 23: No. 3, 1962)

2202 POLARISATION DER RUCKSTOSSNUKLEONEN BEI DER PHOTO-PION-ERZEUGUNG AM WASSERSTOFF. (Polarization of Recoil Nucleons in Photopion Production in Hydrogen). Alfred Muellensiefen. Thesis, Karlsruhe, Ger., Technische Hochschule, 1961. 35p.

For the reaction $\gamma + p = \pi^0 + p$ the recoil proton polarization was calculated in the energy region of the first resonance. Predictions based on amplitude analysis gave for small angles (20-30°) rather large values of the degree of polarization that decrease monotonously with increasing angles. The dispersion theory predicts the same behavior for large angles but negative values for small angles. Possible explanations for these results are discussed. It is argued that results of several authors for higher energies (560-850 Mev) are based on wrong assumptions. In this range the dispersion theory in its present state is no more valid. As shown the results of the non-relativistic calculation can also be used for the relativistic case. (Gmelin)

2203 EINFÜHRUNG IN DIE THEORIE DER ELEMENTARTEILCHEN. (Introduction to the Theory of Elementary Particles). W. Heisenberg. Munich, Universität, 1961. 268p.

The discovery of elementary particles is reviewed. The characteristics of elementary particles are listed. The field equations for mathematical representation of free particles are given. The quantization of the field and the problem of reciprocal effects are discussed. The Lee Model and the problem of the relativistic theory of fields with reciprocal effects are described. The theory of the scattering matrix is outlined. Group-theory properties and the uniform field theory of elementary particles are reviewed. (M.C.G.)

2204 WAHRSCHEINLICHKEITSDICHTEN EINES DIRAC-TEILCHENS MIT KONSTANTEM ELEKTRISCHEM DIPOLMOMENT. (Probability Densities of a Dirac Particle with a Constant Electric Dipole Moment). Erich Landhaeusser. Thesis, Karlsruhe, Ger., Technische Hochschule, 1961. 55p.

The 16 probability densities of a Dirac particle are related by several second order equations. Kofink has demonstrated that 9 primary equations are sufficient. The 16 densities can be expressed as 4 vectors in a three dimensional space, the density vectors of spin, current, and electric and magnetic moments. The orientation of these vectors in space is studied. It is shown that in the general case the first two and the second two vectors are orientated in 2 orthogonal planes. The general solution for an H-atom with an electron having an additional statistical electrical dipole moment is calculated by adding a covariant term to the Dirac equation. The results indicate that the direction of the electric moment is identical with the direction of the radius vector. The properties of a free electron moving along an axis are discussed. (Gmelin)

Neutron Physics

2205 (BNL-6305) MONTE CARLO STUDIES OF U_{238} RESONANCE INTEGRALS. Melvin M. Levine (Brookhaven National Lab., Upton, N. Y.). [1962]. Contract [AT(30-2)-Gen-16]. 8p.

Calculations of resonance escape probability were made for lattices of U^{238} metal, oxide rods, and carbide rods in water and heavy water. The results are presented graphically and compared with those obtained by other investigators using a different model. (J.R.D.)

2206 (LA-1589) YIELD AND ENERGY DISTRIBUTION OF NEUTRONS RESULTING FROM THE INTERACTION OF 14-Mev NEUTRONS WITH Li^6 AND Li^7. F. L. Ribe (Los Alamos Scientific Lab., N. Mex.). Sept. 1953. Contract W-7405-eng-36. 17p. (LADC-1644)

The yield and energy distribution of the lower-energy neutrons resulting from interaction of 14-Mev neutrons with Li^6 and Li^7 were measured at 4 to 12 Mev. It was found that ½ of the total cross section is dependent on small-angle elastic scattering, and that all inelastic processes result in lower energy neutrons spread uniformly in the region from 0 to 12 Mev. (J.R.D.)

2207 (ZFK-TPH-3) DIE BERECHNUNG DER RESONANZENTKOMMWAHRSCHEINLICHKEIT NACH DER THEORIE VON GUREWITSCH-POMERANTSCHUK. (Calculation of Resonance Escape Probability According to the Theory of Gurevich-Pomeranchuk). Horst Meinel (Germany. Zentralinstitut für Kernphysik, Dresden). May 1961. 10p.

The Gurevich-Pomeranchuk theory of resonance absorption is considered. This half-empirical theory gives a view of the process of resonance absorption in heterogeneous reactors and shows good agreement with experimental values. The general formulas are given. The cases of thin and thick rods were considered. (M.C.G.)

2208 (FTD-TT-62-1045) ONE ASYMPTOTIC LAW IN THE THEORY OF NEUTRON MODERATION. M. V. Maslennikov. Translated from Zh. Vychislit. Mat. i Mat. Fiz., 1: 1136-9(1961). 8p.

An examination was made of the problem of the energy-time distribution of neutrons in a homogeneous moderator which fills an entire space whose nuclei are stationary and have mass M. The state of a neutron is defined by assigning the point (U,t) where t is time and U is the lethargy of the neutron. An accurate asymptotic law of the distribution of neutrons of a given lethargy when $t \to \infty$ which is valid in a wide class of cases was sought. (M.C.G.)

2209 A STUDENT MEASUREMENT OF THE DIFFUSION LENGTH OF THERMAL NEUTRONS IN WATER BY A NEGATIVE SOURCE TECHNIQUE. M. M. Bretscher (Valparaiso Univ., Ind.). Am. J. Phys., 30: 814-17(Nov. 1962).

An experiment designed to measure the diffusion length of thermal neutrons in water is described. The technique requires only simple apparatus, and demonstrates the fundamental aspects of neutron diffusion. Using this method the diffusion length is found to be (2.80 ± 0.04) cm. (auth)

2210 A METHOD FOR MEASURING THE DEGREE OF THE NEUTRON BEAM POLARIZATION. N. G. Baazov and A. G. Mandzhavidze. At. Energ. (USSR), 13: 365-6 (Oct. 1962). (In Russian)

A device was developed for obtaining polarized neutrons by reflection from a magnetized Co mirror (Trudy Inst. Fiz. Akad. Nauk Gruz. SSR, being printed), determining the degree of polarization by the double-reflection method or by means of depolarizing shim layers. These measurements are complicated by the depolarization of the beam in the scattered magnetic field or by the re-orientation of the neutron spins in the space between the polarizer and analyzer magnets. A magnetic system was developed for measuring the degree of polarization without using magnetic screens or permanent magnets. It consists of two C-shaped elongated electromagnets, one of which represents an extension of the polarizer magnet while the other reaches up to the analyzer. The initial field of these magnets is 100 oersted, but when the Co mirrors are magnetized to 400 to 500 oersted, the magnets of the system do not have to be energized and serve as magnetic conductors. The problems

arising during the measurement of the degree of polarization of the neutron beam are thus eliminated. (TTT)

2211 NEUTRON DIFFUSION STUDIES FOR WATER AND ICE AT TEMPERATURES NEAR 0° AND −80°C. A. V. Antonov, B. V. Granatkin, Yu. A. Merkul'ev, V. V. Puzanov, and Ch. K. Smolik. At. Energ. (USSR), 13: 373-4 (Oct. 1962). (In Russian)

Interaction of the neutrons with a given moderator material depends not only on the neutron energy and the moderator temperature but also on the latter's state of aggregation. For this reason the behavior of the coefficient of diffusion D and the coefficient of diffisuon cooling C were investigated at the water−ice transition point and at −80°C by means of the nonstationary diffusion pulse method. It was assumed that the neutron lifetime in water is 204 μsec and in ice, 222 μsec. The ratios obtained for D, C, and D^2/C, which defines the energy exchange between the neutron gas and the moderator, for ice and water were found to be 1.0 ± 0.02, 2.50 ± 0.40, and 0.43 ± 0.09, respectively. This indicates that the diffusion coefficient is 4% larger in ice although it should be 1.09 in view of the 9% high density of water; the difference might be due to the fact that the average cosine of the neutron scattering angle, cos Θ, of the water either does not change or it decreases at the water−ice transition. At that time C increases 2.5 times and the D^2/C of the ice increases by 43% with respect to that of water at 0°. Lowering the temperature results in the decrease of the values of D, C, and D^2/C, indicating an increase of the thermalization time. (TTT)

2212 DETERMINATION OF DIFFUSION COEFFICIENTS FOR THERMAL NEUTRONS IN D_2O AT 20, 100, 165, AND 220°C. Norman P. Baumann (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucl. Sci. Eng., 14: 179-85(Oct. 1962).

Diffusion coefficients for thermal neutrons in D_2O were determined at temperatures of 20, 100, 165, and 220°C by measuring the change in neutron relaxation length at each temperature with the addition of known amounts of copper as a neutron poison. The experimental values corresponded closely to calculated values after corrections were made for D_2O purity and neutron spectrum shifts. The corrected diffusion coefficients were 0.841 ± 0.010 cm at 20°C, 0.912 ± 0.011 cm at 100°C, 0.989 ± 0.012 cm at 165°C, and 1.091 ± 0.013 cm at 220°C. (auth)

2213 THE TRANSFER CROSS SECTION BETWEEN OVERLAPPING THERMAL GROUPS. R. M. Pearce (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Sci. Eng., 14: 206-8(Oct. 1962).

The neutron thermalization problem, which involves finding the spatial variation of the thermal neutron spectrum in two adjoining regions at different temperatures T and T_0, is considered. In the treatment of the problem with the overlapping thermal group theory, the spectrum is taken to be $\Phi(x,v) = \phi(x)M(v) + \phi_0(x)M_0(v)$, where v = velocity, x = space coordinate, and M = maxwellian distributions. The diffusion equations are solved with a transfer process, and solutions are given for ϕ and ϕ_0 in the two media. (D.L.C.)

2214 PRODUCTION OF MONOCHROMATIC NEUTRON GROUPS BY TOTAL REFLECTION. Rolf Stockmeyer (Kernforschungsanlage, Jülich, Ger.). Nukleonik, 4: 266-7(Aug. 1962). (In German)

A pulsed monochromator was developed which deflects, as a rotating crystal, neutrons of the desired energy from the direction of the direct beam. The monochromator does not have the disadvantages of the rotating crystals, such as higher-order deflections, diffuse scattering, and low variability of neutron energies. The principle of the monochromator is explained schematically. (J.S.R.)

2215 THE MOST GENERAL EQUATIONS FOR MULTIGROUP NEUTRON DIFFUSION IN P_1 APPROXIMATION. Erdoğan Suhubi (Technical Univ. of Istanbul) and Ahmed Yueksel Oezemre. Nukleonik, 4: 303-6(Oct. 1962). (In English)

Starting from the general transport equation and within the limits of the P_1 approximation, a set of coupled second order partial integro-differential equations was obtained. These equations consider the effect of m groups of retarded neutrons and contain both the first and the second derivatives of the neutron fluxes with respect to the time variable. (auth)

2216 INFLUENCE OF ELECTRON-PHONON INTERACTION ON THE SCATTERING OF NEUTRONS BY CONDUCTING CRYSTALS. J. J. J. Kokkedee (Instituut voor Theoretische Fysica der Rijksuniversiteit, Utrecht). Physica, 28: 893-907(Sept. 1962). (In English)

The theory of the influence of phonon-phonon interactions on the location and width of the one-phonon peaks in the spectrum of neutrons inelastically scattered by single crystals is extended to the case of metals, to include the interaction between phonons and conduction electrons. Expressions are derived for the shift and width as a result of electron-phonon coupling and estimates are given for these quantities. In general, the influence of electron-phonon interaction on the line shape of the scattering peaks is small. (auth)

2217 THE INFLUENCE OF HYDROGEN ON THE MAGNETIC SCATTERING OF NEUTRONS BY A NICKEL−PALLADIUM ALLOY. J. J. van Loef (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands) and W. van Dingenen. Physica, 28: 917-18(Sept. 1962). (In English)

The single transmission effect (characterized by the coefficient η) in the scattering of 1.7- to 5-Å neutrons is measured in Pd−46 at.% Ni foils. The H/Pd atomic ratio in the foils varies from 0 to 0.6. Measurements are made in magnetic fields of 0 and 6 kOe. The square root of η, as well as the magnetization of the foil, is found to have the same linear dependence on the H/Pd ratio. The single transmission effect in this system is concluded to be nonanomalous. (T.F.H.)

2218 THE THEORY OF SLOW NEUTRON SCATTERING IN SOLID SOLUTIONS WITH SPINEL TYPE STRUCTURE AS A FUNCTION OF THE COMPOSITION AND DEGREE OF INVERSION. Yu. A. Izyumov and A. N. Men' (Inst. of Physics of Metals, Academy of Sciences, USSR and Inst. of Metallurgy of the Urals Branch, Academy of Sciences, USSR). Soviet Phys.-Cryst. (English Transl.), 7: 286-8(Nov.-Dec. 1962).

Theoretical formulas that can be used to determine the dependence of the effective cross section of elastic scattering of slow neutrons in solid solutions with a spinel-type structure on the composition and degree of inversion were obtained. (auth)

2219 THE EFFECT OF TEMPERATURE ON DIFFUSION PARAMETERS OF HEAVY WATER. Nripendra Kumar Ganguly. Thesis, Raleigh, North Carolina State Coll., 1962. 56p.

Measurements of the diffusion parameters of heavy water were made using a 1-Mev Van de Graaff accelerator utilizing the $Be^9(d,n)$ reaction under pulsed operation. The measurements were made at temperatures of 10, 20, 31, 40, and 50°C. For each temperature, six different sets of measurements of the decay constant were made by varying

the height of the heavy water in the cylinder. The smallest buckling value corresponding to the initial maximum height of D_2O in the water was about 0.063 cm^{-2}. The highest value of buckling used in each set of experiments was about 0.100 cm^{-2}. The test cylinder was isolated from extraneous neutrons by a shield consisting of an inner shell of Cd surrounded by 1 inch of borax. This reduced the room background to a negligible amount. To avoid moderator contamination by atmospheric moisture, a closed liquid transfer system was employed between the moderator container and an external reservoir. The system was filled with argon. A BF_3 counter was located under the moderator container and was connected to a 26-channel time analyzer having a channel width of 9.57 microseconds. The mean-life, λ, for each buckling was computed using Peierls's method. Values of constants D_0 and (c-d) for each set were computed by the method of least squares, using the relation, $\lambda = \lambda_a + D_0B^2 - (c\text{-}d)B^4$. Assuming $\lambda_a \approx 0$, and correcting for the 0.12 percent light water impurity, the values obtained are listed. Since the extrapolation distance is related to D_0, the Remington Rand Univac 1105 was used to obtain self-consistent values of bucklings through an iterative process, which was in turn used in the least square calculation. The value of D_0 agrees, within the limits of experimental error, with that found by Raievski and Horowitz in 1954, who used the modulated source method. The nature of (c-d) at 20°C compares favorably with that found by Sjostrand in 1959, who reported $3.5 \pm 0.8 \times 10^5/cm^4/sec$ as its value. (Dissertation Abstr., 23: No. 3, 1962)

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Refer also to abstract 1764.

2220 (EUR-12.e) MEASUREMENT OF THE THERMAL NEUTRON ABSORPTION CROSS SECTION OF BORON BY MEANS OF A TIME OF FLIGHT TECHNIQUE. A. Deruytter (Mol, Belgium. Centre d'Etude de l'Energie Nucléaire); G. Debus, K. Lauer, H. Moret, and A. Prosdocimi (European Atomic Energy Community). May 1962. 41p.

A precise determination of the neutron absorption cross section of boron in the thermal energy region 0.006 to 0.082 ev was undertaken by means of time-of-flight technique. Two samples of deuterated boric acid solution in heavy water were measured, containing respectively 19.81 and 96.51% of B^{10}. The following results were obtained (at 0.0253 ev): sample n^0 1, $\sigma_a = (761 \pm 2)$b; and sample n^0 2, $\sigma_a = (3703 \pm 9)$b; from which the following values for the absorption cross section of B^{10} were respectively derived: $\sigma_a(B^{10}) = (3840 \pm 11)$b; and $\sigma_a(B^{10}) = (3837 \pm 9)$b. Their weighted mean is equal to (3838 ± 10)b. (auth)

2221 (IEA-52) ON THE PEIERLS' METHOD OF MEAN-LIFE DETERMINATION. W. S. Hehl, H. R. Franzen, and P. S. Toledo (Brazil. Instituto de Energia Atômica, São Paulo). June 1962. 19p.

The problem of the determination of the disintegration constant of a radioisotope when the variation of counts with time is known was considered by Peierls for the case when the intervals of counts are small compared with the mean life. This assumption was discarded and a formula obtained that allows determination of the mean life when counts are taken during equal intervals of time equally spaced and not necessarily small when compared with the mean life. An expression for the error involved in this determination of mean life was also obtained. A simplified expression for the calculation of the mean life for the case of small intervals of counting, separated by intervals of finite width, is presented. (M.C.G.)

2222 (JINR-P-1010) ANALIZ USREDNENNYKH SECHENII ZAKHVATA NEITRONOV. (Analysis of Averaged Neutron Capture Cross Sections). Yu. P. Popov and Yu. I. Fenin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Neutron Physics). 1962. 15p.

A method is described of analyzing the averaged neutron capture cross sections in the energy region of ~1 to 15 kev to obtain the characteristics of p-neutron-nuclei interaction. An analysis was made of the capture cross sections measured by means of a neutron spectrometer based on the slowing down time in lead for the nuclei of Br, Rb^{85}, Nb, Mo^{98}, Mo^{100}, Rh, Ag, In, Sb, I, Cs, and Ir. The obtained values of the strength functions of p-neutrons are compared with the data of other investigators and with the predictions of the nuclear optical model. (auth)

2223 (KAPL-2214) THE $O^{16}(n,p)N^{16}$ CROSS SECTION FROM 12.6 TO 16.3 Mev. K. W. Seeman and W. E. Moore (Knolls Atomic Power Lab., Schenectady, N. Y.). Sept. 21, 1962. Contract W-31-109-eng-52. 53p.

The cross section for the reaction $O^{16}(n,p)N^{16}$ was measured in the neutron energy range $12.6 < E_n < 16.3$ Mev. Neutrons were produced by the $T(d,n)He^4$ reaction, using 800-kev deuterons from a Cockcroft-Walton accelerator. A triple-coincidence proton-recoil neutron spectrometer was used to measure the absolute neutron yield from the tritium target as a function of angle. An oxygen-bearing liquid scintillator was bombarded in an annular ring concentric with the incident deuteron beam. After bombardment, the scintillant was transferred to a shielded photomultiplier assembly where the β decay of the 7.36-sec N^{16} activity was observed. Absolute cross sections were obtained at intervals of ~170 kev over the energy range mentioned above. Neutron energy spreads at each point ranged from ±40 to ±120 kev. Peaks in the excitation function were resolved at energies of 13.50 ± 0.10, 14.10 ± 0.10, and 15.10 ± 0.05 Mev. By using the results of DeJuren, et al., in conjunction with the results of this experiment, it was found that the integral of the $O^{16}(n,p)N^{16}$ excitation function over the Watt fission spectrum is 99.5 μb. (auth)

2224 (NIRL/R/16) PROCEEDINGS OF A SYMPOSIUM ON POLARIZATION PROCESSES BELOW 50 Mev HELD AT THE RUTHERFORD HIGH ENERGY LABORATORY, HARWELL, ON OCTOBER 23 AND 24, 1961. (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Harwell, Berks, England). Dec. 1961. 92p.

Seventeen papers are included, for each of which a separate abstract was prepared. (J.R.D.)

2225 (NIRL/R/16(p.1-3)) THE RUTHERFORD LABORATORY POLARIZED PROTON SOURCE. G. H. Stafford (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Harwell, Berks, England). 5p.

The design and operation of the proton source are discussed, and plans for improvement are outlined. (J.R.D.)

2226 (NIRL/R/16(p.5-7)) THE PRESENT STATE OF THE ANALYSIS OF p-p SCATTERING. J. K. Perring (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). 3p.

Existing gaps in the technology are discussed, and ways of enlarging on basic information are suggested. It is noted that the most useful experiments which can be done with the polarized source are those concerned with P, D, and A

waves; these experiments should be performed at more than one energy. (J.R.D.)

2227 (NIRL/R/16(p.9-10)) MEASUREMENT OF THE POLARIZATION PRODUCED IN 30 AND 50 Mev p-p SCATTERING AT 45° c.m. C. J. Batty, G. H. Stafford (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Harwell, Berks, England) and R. Gilmore (Queen's Univ., Belfast). 3p.

The initial measurements are planned at a scattering angle of 45° c.m. where the polarization maximum is expected. As a check on the magnitude of possible remaining asymmetries, the polarization at 90° c.m. will be measured simultaneously; this value is expected to be zero. The largest systematic error is expected to result from beam movement over the target, causing a change in the solid angle apparent to each counter. A diagram of the proposed experiment is included along with values obtained by other workers and data pertaining to the proposal. (J.R.D.)

2228 (NIRL/R/16(p.11-12)) MEASUREMENT OF A AND R FOR p-p SCATTERING AT 50 Mev. A. Ashmore, B. Hird, and J. Litt (London. Univ. Queen Mary Coll.). 3p.

The experiment is planned so that the incident proton beam is horizontally polarized, either longitudinally for A or transversely for R. The liquid H_2 target is 1 in. in diameter. Helium analyzers to measure the up-down asymmetry are arranged on either side of the proton beam. A diagram of the experimental apparatus is included. (J.R.D.)

2229 (NIRL/R/16(p.13-15)) MEASUREMENT OF THE SPIN-CORRELATION COEFFICIENTS IN p-p SCATTERING. T. C. Griffith, D. C. Imrie, G. J. Lush (London. Univ. University Coll.); M. F. Audus and J. J. Thresher (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Harwell, Berks, England). 3p.

An experimental plan is discussed in which two high-pressure He analyzers are used to measure the spin correlation of the scattered and recoil protons at 45° from a liquid H_2 target bombarded by unpolarized 50-Mev protons. Both C_{NN} and C_{KP} are to be measured in the same experiment. Aspects of design such as those concerned with the target, counters, and beam analysis and control are discussed along with estimates of error. (J.R.D.)

2230 (NIRL/R/16(p.17-22)) POLARIZATION EFFECTS IN NUCLEON-DEUTERON SCATTERING. L. Castillejo (Birmingham. Univ., England). 6p.

It is noted that because of the general properties of the nucleon-deuteron system, exact calculation of polarization effects is difficult, and it is a practice to seek features that are dominated by processes that can be calculated. The main approximations considered are for low-energy and high-energy impulses. These approximations are discussed along with spin and the results of elastic and inelastic scattering. (J.R.D.)

2231 (NIRL/R/16(p.23-8)) THE p + He^4 INTERACTION. J. L. Gammel (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England) and Leona Steward (Los Alamos Scientific Lab., N. Mex.). 8p.

Preliminary results of experiments in which the p + He^4 polarization at 14.4 and 14.32 was measured are discussed. The analysis of the data is not complete; however, results obtained by setting L_{max} at 1, 2, and 3 are tabulated. Discussion of these results in relation to predicted polarization is included. It is concluded that measurement of the R phase shift would be of value. (J.R.D.)

2232 (NIRL/R/16(p.29-30)) EXPERIMENTS ON POLARIZATION IN p-α SCATTERING. B. W. Davies (London. Univ. King's Coll.); M. K. Craddock (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Harwell, Berks, England); and R. C. Hanna (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). 2p.

Experiments planned to measure the scattering asymmetry of polarized protons are described in which polarization as a function of angle and energy in p-α scattering will be determined. The asymmetry at 22 Mev is to be measured first with a polarized beam; the value thus obtained will be used in higher-energy measurements. Other information concerning techniques and apparatus is included. (J.R.D.)

2233 (NIRL/R/16(p.31-3)) POLARIZATION AND TRIPLE SCATTERING EXPERIMENTS IN THE ELASTIC SCATTERING OF PROTONS BY NUCLEI. G. E. Brown (Nordisk Institut Teoretisk Atomfysik, Copenhagen). 10p.

The validity and applicability of the optical model of the nucleus are discussed. Other discussion concerning the validity of this model in a description of scattering by light nuclei is also given. The resemblance of the polarization curve and the form of the differential cross section in experiments is discussed. Data are included on the distribution of protons scattered from C at 11 to 19 Mev, variation of the optical model parameters with energy, polarization data fits, scattering of 10.5-Mev protons by O^{16}, and effects of adding a small imaginary part to the spin-orbit potential. (J.R.D.)

2234 (NIRL/R/16(p.35-7)) EXPERIMENTAL WORK ON PROTON ELASTIC SCATTERING POLARIZATION. G. W. Greenlees (Birmingham. Univ., England and Nordisk Institut for Teoretisk Atomfysik, Copenhagen). 7p.

Methods of measuring the polarization of elastically scattered protons below 50 Mev are compared. One such method is described in which the unknown is the first target, and the scattered beam is analyzed using a target of known properties. A second method is discussed in which a beam of known polarization is obtained and is then scattered from the unknown. Data obtained by use of these methods are included. (J.R.D.)

2235 (NIRL/R/16(p.39-40)) POLARIZATION IN PROTON-CARBON SCATTERING AT 30 Mev. R. M. Craig, J. C. Dore, G. W. Greenlees, J. S. Lilley (Birmingham. Univ., England) and P. C. Rowe (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Harwell, Berks, England). 6p.

Measurements were made of the polarization of 30-Mev protons scattered elastically and inelastically from C. The experimental equipment is described, and data on inelastic and elastic polarization at 28 Mev are included. (J.R.D.)

2236 (NIRL/R/16(p.41-6)) THEORY OF POLARIZATION EFFECTS IN (p,d) AND (p,p) REACTIONS. L. J. B. Goldfarb (Manchester, England. [Univ.]). 6p.

A discussion is presented which is mainly concerned with the deuteron pick-up process and allied phenomena. Rules which apply to pick-up processes are summarized. These rules are independent of the nuclear excitation state and may be found by referring to the inverse stripping process and then noting the results which may apply. (J.R.D.)

2237 (NIRL/R/16(p.47-9)) MEASUREMENTS OF POLARIZATION EFFECTS IN (p,d) AND (p,p′) REACTIONS. B. Hird (London. Univ. Queen Mary Coll.). 8p.

A survey of research on (p,d) and (p,p′) reactions at energies below 50 Mev is presented. Data are presented and discussed on the $C^{12}(d,p)C^{13}$ reaction at 4.05 to 15 Mev, ground-state polarization of the reaction $Ca^{40}(d,p)Ca^{41}$, polarization of the Q = −4.43-Mev inelastic group in the reac-

tion $C^{12}(p,p')C^{12}$, and asymmetry results as compared with elastic asymmetries. (J.R.D.)

2238 (NIRL/R/16(p.51-2)) POLARIZATION EFFECTS IN THE PICK-UP PROCESS, $p + Si^{29} \rightarrow d + Si^{28}$. L. J. B. Goldfarb, M. Hooper, and R. C. Johnson ([Manchester, England. Univ.]). 4p.

Calculations concerning the pick-up process $p + Si^{29} \rightarrow d + Si^{28}$ that leads to the nuclear ground state with an angular-momentum transfer equal to zero are discussed. Distortion of both incoming and outgoing waves is taken into account, and reasonable optical-model parameters are used. (J.R.D.)

2239 (NIRL/R/16(p.53-5)) MECHANISM OF NUCLEAR REACTIONS AT LOW ENERGIES. G. E. Brown (Nordisk Institut for Teoretisk Atomfysik, Copenhagen). 3p.

The experimental applications of 40-Mev proton beams are discussed. Aspects of (p,d) reactions in Ni and Ca, (p,2p) reactions in Ca^{40}, and (p,n) on nuclei with isobaric spin equal to 0 are examined. (J.R.D.)

2240 (NIRL/R/16(p.57-60)) POLARIZATION EFFECTS IN (p,γ) REACTIONS. P. S. Fisher (Oxford Univ. Clarendon Lab.). 4p.

The (p,γ) reactions which form intermediate states with excitations in excess of about 20 Mev are discussed. Dipole states and other collective states encountered at this energy level are examined. It is noted that the polarized proton beam could be useful in elucidating details of the high-lying collective states of nuclei when these overlap. (J.R.D.)

2241 (NIRL/R/16(p.61-7)) POSSIBLE EXPERIMENTS USING POLARIZED NEUTRON BEAMS. R. Gilmore (Queen's Univ., Belfast). 8p.

The production of a polarized neutron beam and measurement of its polarization are discussed. It is noted that polarized neutrons may be produced by scattering processes with proton beams and suitable targets. Methods for determining neutron polarization by (p,n) experiments are summarized, and a comparison of neutron polarimeters is presented. (J.R.D.)

2242 (TID-16949) RARE NUCLEAR REACTIONS INDUCED BY 14.8 Mev NEUTRONS (thesis). Edward Turner Bramlitt (Arkansas. Univ., Fayetteville). [1962]. 227p.

Activation cross sections for neutrons at 14.8 ± 0.8 Mev were measured for [(n,nα) + (n,αn)] reactions on the isotopes Cu^{65}, Zn^{70}, Ga^{71}, and Nb^{93} while maximum cross-section limits for this reaction were determined for V^{51}, Ge^{76}, Br^{81}, Rb^{87}, Ag^{107}, Ag^{109}, In^{115}, Au^{197}, and Tl^{203}. Cross-section limits also were established for (n,2p) reactions on Si^{29}, K^{41}, Sc^{45}, Ti^{50}, V^{51}, Mn^{55}, As^{75}, Y^{89}, Nb^{93}, Cs^{133}, La^{139}, Pr^{141}, and Tb^{159}; and for (n,He^3) reactions on K^{41}, Sc^{45}, V^{51}, Mn^{55}, Co^{59}, Cu^{63}, As^{75}, Nb^{93}, Rh^{103}, Cs^{133}, Au^{197}, and Tl^{205}. Cross-section values for (n,γ) reactions on Y^{89}, Nb^{93}, and Pr^{141} and cross-section limits for (n,3n) reactions on Pr^{141}, Au^{197}, and Tl^{205} were determined. The [(n,np) + (n,pn)] reaction was detected with Ni^{58} but not with Mo^{92}. A cross-section value was established for the former and a maximum limit for the latter. Absolute disintegration rates required for these determinations were obtained by employing beta and gamma counting methods, while monitor reactions served to eliminate neutron flux measurements. Extensive use was made of radiochemical separations in order to isolate the low-yield, rare-reaction products. Cross sections for (n,p), (n,α) and (n,2n) reactions were investigated. Theoretical cross sections determined for (n,αn) reactions were found to agree with the experimentally determined [(n,nα) + (n,αn)] cross sections, thereby suggesting that the path for this reaction sum is predominantly an (n,αn) process. The corresponding experimental (n,αγ) cross sections were predicted within a factor of two. The Statistical Theory predicts (n,2p) cross sections to be significant for certain low-Z nuclides, e.g., Cr^{50}, Ni^{58}, Kr^{78}, and Mo^{92}. None of these particular nuclides is susceptible to investigation by activation methods. Generally, the theoretical estimates for (n,2n) cross sections were in agreement with the experimental cross sections. Both (n,αγ) and (n,pγ) theoretical estimates were much lower than experimental for the higher-A nuclides studied; however, this difference is less for lower-A nuclides. The theoretical (n,αγ) cross sections agree with experiment more often than do the (n,pγ) cross sections. (auth)

2243 (TID-17083) STUDIES RELATING TO SCATTERING OF NEUTRONS AND ALLIED PHENOMENA. Annual Progress Report for 1962. D. M. Van Patter (Bartol Research Foundation, Swarthmore, Penna.). Contract AT(30-1)-1679. 44p.

Experimental results for the $Y^{89}(n,n'\gamma)$ reaction are summarized, including the primary γ-ray decay modes for eight low-lying states of Y^{89}. The significance of the $\frac{3}{2}$- and $\frac{5}{2}$-spin assignments for the 1.51- and 1.75-Mev levels of Y^{89} is discussed. Angular distribution measurements for (n,n'γ) radiations from Sr^{88}, Y^{89}, and Ce^{140} are in progress. Polarization measurements were made for the scattering of 3.3-Mev neutrons from Ca, Zn, Se, Sr, Y, Ag, In, and Sb. Experimental studies relating to (p,mγ) reactions included the measurement of a thin-target excitation curve of 393-kev radiation arising from the $Sr^{88}(p,n\gamma)Y^{88}$ reaction, which followed a $(\Delta E)^{\frac{1}{2}}$ law near threshold. Studies of radioactivities produced by (p,n) reactions yielded improved γ energies for some of the prominent γ rays from 78-hr Zr^{89} (908 ± 3, 1703 ± 9 kev) and 4.2-min Zr^{89m} (1506 ± 5 kev) and an improved value for the half life of Zr^{89} (preliminary value: 78.4 ± 0.1 hr). An experimental study of gamma-gamma angular correlations perturbed by the hyperfine interaction was initiated, with the objective of investigating nuclear moments of excited states. In this connection, a theoretical investigation of a correlation perturbed by a static anisotropic hyperfine interaction was undertaken. One feature of the theoretical results was that under certain conditions, an "angular correlation resonance experiment" is possible, in which the coincidence counting rate, for fixed positions of the detectors, exhibits sharp interference peaks as a function of the magnetic field. It was also possible to predict the decoupling behavior of nuclear and electronic spins over the entire range of magnetic field strengths. Theoretical work on the statistical model of nuclear reactions centered on the long range correlations apparent in low energy nuclear states and their relation to the nuclear level density at higher energies. The high energy behavior of two nuclear models with pairing correlations was studied; i.e., for a model with a constant pairing energy between particles in doubly occupied pair states, and for the superconducting model. (auth)

2244 (TID-17183) THE DECAY OF Sc^{44} AND Sc^{44m}. L. T. Dillman, J. J. Kraushaar (Colorado. Univ., Boulder); and J. D. McCullen (Princeton Univ., N. J.). [1962]. Contract AT(11-1)-535. 24p. (UCOL-P-513)

The decay of the Sc^{44} g.s. was investigated using a Ti^{44} source and scintillation spectrometry. In addition to the main mode of decay to the 1.16-Mev level in Ca^{44}, there is a weak electron capture transition to a 2.67-Mev level

which is depopulated by a 1.50 to 1.16-Mev gamma cascade and a weak 2.67-Mev crossover transition. The Sc^{44m} (2.4 day) decay was reinvestigated and the results compared with the Sc^{44} g.s. decay. This comparison showed that there are weak electron capture branches from the isomeric level directly to excited levels of Ca^{44}. The main feature of the Sc^{44m} decay is the population of a level in Ca^{44} at 3.30 Mev followed by a triple cascade involving gamma rays of 1.02, 1.12, and 1.16 Mev. The spins of the ground state and the isomeric level of Sc^{44} were recently measured to be 2+ and 6+, respectively. This knowledge coupled with information concerning the decay process made possible the assignment of spins and parities to a number of the excited levels of Ca^{44}. (auth)

2245 (UCRL-7032) THE CERENKOV RESPONSE OF LUCITE AND QUARTZ TO GAMMA AND FAST NEUTRON RADIATION. J. E. Doyle and W. C. Dickinson (California. Univ., Livermore. Lawrence Radiation Lab.). July 5, 1962. Contract W-7405-eng-48. 28p.

Experiments were conducted to evaluate the effectiveness of Lucite and quartz as Cherenkov materials for fast gamma detectors. The relevant theory is presented as an aid in interpreting and extrapolating the experimental results. It was found that Lucite is a satisfactory Cherenkov material, showing negligible luminescence and good discrimination against neutrons relative to the LRL plastic fluor. (auth)

2246 (UCRL-10429) ATOMIC CAPTURE OF μ^- MESONS IN CHEMICAL COMPOUNDS AND THE "FERMI-TELLER Z LAW" (thesis). Jagdish S. Baijal (California. Univ., Berkeley. Lawrence Radiation Lab.). Aug. 20, 1962. Contract W-7405-eng-48. 76p.

Experimental studies of the relative atomic μ^--meson capture probabilities in the constituents of chemical compounds are described. Fermi and Teller had predicted that the atomic-capture probability is proportional to the nuclear charge of the atomic species weighted by its atomic concentration. This is sometimes referred to as the "Fermi-Teller Z law." Previous experiments indicated no clear systematics to this capture process, and there are conflicts between the results of several measurements made with the same or similar compounds. In these experiments the capturing atom was identified by detection of either mesic x rays or decay electrons from μ^- mesons bound in the mesic K shell in the atomic species. In these experiments oxides and sulfides of some medium- and high-Z elements as well as two metallic solutions were used, and a nuclear capture product (neutron) rather than the decay electrons was detected. Results show that among the substances examined, namely CuO, Sb_2O_3, PbO, CuS, Sb_2S_3, PbS, AgLi, and CuAu, the "Z law" behavior is not indicated either in insulators or in metals, although in all cases there is a preference for capturing in the atom of higher Z. If the atomic-capture probability is proportional to Z^n (n being any positive or negative number), then it is found that the experimental results fall approximately in the range $n = \frac{2}{3}$ to n = 1.4, where n = 1 would define the prediction by Fermi and Teller. The measured atomic-capture ratios are: Cu/O = 6.14 ± 0.85; Sb/O = 1.86 ± 0.096; Pb/O = 4.56 ± 0.53; Cu/S = 1.89 ± 0.18; Sb/S = 1.64 ± 0.10; Pb/S = 2.87 ± 0.35; Ag/Li = 11.66 ± 3.39; Au/Cu = 0.34 ± 0.032. In connection with this experiment it was also necessary to measure the μ^--meson lifetimes in a number of elements (including Au, which was not reported before). The measured lifetimes are (in nsec): S = 498 ± 17; Cu = 162.6 ± 1.9; Ag = 84.4 ± 1.0; Sb = 91.3 ± 1.4; Au = 68.6 ± 1.3; Pb = 74.1 ± 1.0. (auth)

2247 (AEC-tr-5493) SHARP-SURFACE SYMMETRICAL SHAPES OF NUCLEAR EQUILIBRIUM. V. M. Strutinskii, N. Ya. Lyashchenko, and N. A. Popov (Akademiya Nauk S.S.S.R. Ordena Lenina Institut Atomnoi Energii). Translated by Lydia Venters (Argonne National Lab., Ill.). Oct. 1962. 40p.

Basic results obtained by calculation of the symmetrical shapes of nuclear equilibrium are presented. A family of conditional-equilibrium shapes is studied in which a parameter value (D) is used that characterizes the nuclear deformation. Calculation results are included along with a description of an iteration method used in the determinations. (J.R.D.)

2248 (KFK-tr-114) GRUNDSÄTZLICHE BETRACHTUNGEN ZUR RÜCKSTREUUNG VON BETA-STRAHLEN. (Fundamental Considerations in the Backscattering of Beta Rays). H. Mori and S. Taira. Translated into German by Peter Buriks (Kernreaktor Bau- und Betriebs-Gesellschaft m.b.H., Karlsruhe, Germany) from Bunseki Kagaku, 10: 1326-31(1961). 12p.

The Pb, Fe, Al, and C samples were irradiated with β particles from Sr^{90}. With the help of a collimator the back-scattered radiation at a definite scattering angle was detected by a G-M counter. In this way for absorption curves of the different elements, scattered radiation was plotted versus various scattering angles. In order to increase the sensitivity of the method, only scattered radiation at optimal scattering angles was measured. It is recommended that a filter of suitable thickness be placed on the detector window. The relation between the back-scattering factor and atomic number of the individual elements was investigated. (tr-auth)

2249 (UCRL-Trans-258) THE EXCITATION OF ROTATION LEVELS DURING ALPHA-DECOMPOSITION. V. G. Nosov. Translated by Richard B. Mudge (Univ. of California Lawrence Radiation Lab., Berkeley) from Dokl. Akad. Nauk SSSR, 103: No. 1, 65-7(1955). 7p.

The discussion concerns comparison of theory and experimental results using the assumptions that the nuclei under consideration are flat in one case and elongated in another. It is shown that available data on alpha decay can be more readily reconciled with the theory of nuclear flatness in the U group than with the idea of their elongation. (J.R.D.)

2250 ALPHA BRANCHING IN THE DECAY OF Pb^{210} AND Bi^{210}. A NEW MERCURY ISOTOPE Hg^{206}. Pentti Kauranen (Univ. of Helsinki). Ann. Acad. Sci. Fennicae, Ser. A VI, No. 96, 1-30(1962). (In English)

Measurements are reported of the Bi^{210} alpha-decay branching ratio ($(1.32 \pm 0.10) \times 10^{-6}$) and the Pb^{210} alpha branching ratio and energy ($(1.7 \pm 0.3) \times 10^{-8}$ and 3.72 ± 0.02 Mev). The beta energy and half life of Hg^{206} are determined; the Hg^{206} can be produced either by alpha decay of Pb^{210} or by the reaction $Pb^{208}(p,3p)Hg^{206}$. (T.F.H.)

2251 AN INVESTIGATION OF NEUTRONS FROM THE REACTION $Mg^{25}(d,n)Al^{26}$ AT 2.00 AND 6.54 Mev DEUTERON ENERGY. A. Erdal and A. Graue (Univ. of Bergen). Arbok Univ. Bergen, Mat.-Nat. Ser., No. 15, 1-7(1960). (In English)

The neutrons emitted from thin Mg^{25} targets bombarbed by 2.00- and 6.54-Mev deuterons are investigated using the photographic plate technique. The Q-values corresponding to the ground state in Al^{26} are found to be 4.10 ± 0.05 and 4.07 ± 0.09 Mev respectively. A probable level at 0.61 Mev is observed. (auth)

2252 NEUTRON ANGULAR DISTRIBUTIONS FROM THE REACTION $B^{11}(\alpha,n)N^{14}$ AT 13.9 AND 13.5 Mev. J. Kjellman (Research Inst. of National Defence, Stockholm and Nobel Inst. of Physics, Stockholm). Arkiv Fysik, 21: 543-50(1962). (In English)

The angular distributions of the neutrons to the ground state and the second excited state of N^{14} from the reaction $B^{11}(\alpha,n)N^{14}$ are measured at 13.9 and 13.5 Mev. Theoretical fits in terms of the plane-wave Born-approximation direct-interaction theory are given for the higher α energy. (auth)

2253 A STUDY OF THE REACTION $C^{13}(\alpha,n)O^{16}$ AT 14.1, 13.7 AND 12.8 Mev. A. Nilsson and J. Kjellman (Nobel Inst. of Physics, Stockholm and Research Inst. of National Defence, Stockholm). Arkiv Fysik, 21: 551-8(1962). (In English)

The angular distributions of the neutrons to the ground state of O^{16} from the reaction $C^{13}(\alpha,n)O^{16}$ are measured at 14.1, 13.7, and 12.8 Mev. All three distributions show a forward maximum, the amplitude of which increases rather rarkedly with decreasing bombarding energy. At the same time the yield in the backward directions decreases, leading to approximately the same total cross section (≈1 mb) for the three α energies. Some information is gained about the excitation of higher levels in O^{16}, but no separated angular distributions are measured. (auth)

2254 UPPER LIMIT FOR DOUBLE QUANTUM EMISSION FROM NUCLEAR LEVELS IN K^{41} AND Rb^{85}. Torsten Alvaeger, Hans Ryde, and Pedro Thieberger (Nobel Inst. of Physics, Stockholm). Arkiv Fysik, 21: 559-73(1962). (In English)

A search for double quantum emission as a competing process to M2 transitions in K^{41} and Rb^{85} is undertaken. The emitted gamma radiation is detected by two NaI(Tl) crystals and a sum coincidence technique is used. Upper limits for the ratio (probability for double quantum emission)/(probability for single quantum emission) are found to be 6×10^{-5} for the 1.29-Mev level in K^{41} and 1.2×10^{-5} for the 0.514-Mev level in Rb^{85}. (auth)

2255 AN INSTRUMENT FOR THE STUDY OF MOMENTS OF EXCITED NUCLEAR STATES BY ANGULAR CORRELATION METHODS. PART A: PRINCIPLES OF MEASUREMENTS WITH A 4-DETECTOR SYSTEM AND APPLIED EXTERNAL FIELDS. CONSTRUCTION OF A NEW 60,000 GAUSS ELECTROMAGNET BASED ON THESE PRINCIPLES. B. Erik Karlsson. Arkiv Fysik, 22: 1-25 (1962). (In English)

Methods for measuring small perturbations in γ angular correlations with accuracy are presented. The sensitivity of the measurements is increased by using a multi-detector system. It is shown that the inherent symmetry properties of a 4-detector system can be utilized for reduction of systematic errors. A 60,000-gauss electromagnet is constructed for this application, and possibilities of applying magnetic fields both parallel and perpendicular to the detected radiations add to the flexibility of the arrangement. In connection with each particular application, possible experiments are outlined. (auth)

2256 AN INSTRUMENT FOR THE STUDY OF MOMENTS OF EXCITED NUCLEAR STATES BY ANGULAR CORRELATION METHODS. PART B: ELECTRONIC EQUIPMENT. TEST METHODS AND PERFORMANCE OF THE SYSTEM. B. Erik Karlsson, Eckart Matthias, and Carl-Axel Lerjefors. Arkiv Fysik, 22: 27-39(1962). (In English)

Features of a detecting system made for measuring small perturbations in γ angular correlations are discussed. Four detectors are used, and information from these is collected in several coincidence circuits simultaneously. The operation of the detectors in the vicinity of strong magnetic fields is also of interest. A summary is given of results obtained. (auth)

2257 NUCLEAR G-FACTOR OF THE 113 kev ROTATIONAL STATE IN THE ODD A NUCLEUS Hf^{177}. E. Matthias, E. Karlsson, and C.-A. Lerjefors (Univ. of Uppsala). Arkiv Fysik, 22: 139-46(1962). (In English)

The shift of the 208 kev–113 kev angular correlation in Hf^{177} is measured in external magnetic fields of 53,100 and 29,200 gauss. With a half-life of (0.52 ± 0.02) nsec for the 113-kev state this shift leads to a g-factor of +0.232 ± 0.013. An investigation of the internal perturbation by varying the viscosity of the source yields that the perturbation, if present, is smaller than 2%. The result is discussed in terms of the unified model. (auth)

2258 DECAY STUDIES IN THE NEUTRON-DEFICIENT Au-ISOTOPES. PART A: ODD ISOTOPES. Ingvar Marklund, Erik Karlsson, and Kaj Korkman (Inst. of Physics, Uppsala). Arkiv Fysik, 22: 289-306 (1962). (In English)

The decay of neutron-deficient Au isotopes produced in the reactions Pt(p,xn)Au is studied with a semi-circular beta spectrograph and three double-focusing beta spectrometers. A decay scheme including 14 levels is proposed for the decay $Au^{191} \rightarrow Pt^{191}$(3.0 hr). For $Pt^{191} \rightarrow Ir^{191}$(3 days) and Au^{193}(17 hr) information on high-energy transitions and energy values is obtained. The stronger transitions are analyzed with respect to multipolarities, and tentative spin assignments are given to some of the levels. (auth)

2259 DETERMINATION OF THE MAGNETIC MOMENT OF THE FIRST EXCITED STATE IN Sc^{44}. Ingmar Bergstroem and Pedro Thieberger (Royal Inst. of Tech., Stockholm and Nobel Inst. of Physics, Stockholm). Arkiv Fysik, 22: 307-15(1962). (In English)

The g-factor of the 153-nsec first excited state in Sc^{44} is determined by studying the oscillations around the exponential decay curve that appear when the sample is placed in a magnetic field. With the assumption that paramagnetic effects can be neglected a value for the g-factor of +0.35 ± 0.02 is obtained as an average of three different runs. From angular correlation measurements an anisotropy of +9.5 ± 2.5 per cent is obtained. The amplitude of the oscillations corresponds to an anisotropy of +6.5 ± 1 per cent. This result supports the assumption that the multipolarities involved are pure M1 and that the spin sequence is 1, 2, and 3 units, which corresponds to an anisotropy of +7.7%. The magnetic moment of the 153-nsec state is then +0.70 ± 0.04 nuclear magnetons. (auth)

2260 STUDIES OF THE DECAY SCHEME OF Yb^{169} BY MEANS OF AN ELECTRON-ELECTRON AND ELECTRON-GAMMA COINCIDENCE TECHNIQUES. M. S. El-Nesr and E. Bashandy (Univ. of Uppsala). Arkiv Fysik, 22: 317-26(1962). (In English)

The decay scheme of Yb^{169} is investigated using electron-electron and electron-gamma coincidence spectrometers. The branching ratios of transitions in the Tm^{169} nucleus are determined. The K conversion probabilities of the 240- and 261-kev transitions are determined from electron-electron coincidence measurements. These transitions are found to have an electric dipole character. In addition, the K conversion coefficient of the 308-kev transition is determined to be in agreement with theoretical predictions for a pure electric quadrupole transition. (auth)

2261 A MEASUREMENT OF THE LIFETIME OF THE FIRST EXCITED STATE IN Er^{166}. E. Bashandy and M. S. El-Nesr (Univ. of Uppsala). Arkiv Fysik, 22: 341-8(1962). (In English)

The half life of the first excited state in Er^{166} is measured by a delayed electron-electron coincidence technique. The value of $T_{\frac{1}{2}} = (1.9 \pm 0.1)\ 10^{-9}$ sec is obtained. The

transition probability is calculated and compared with the estimated value from the single particle model. An enhancement factor of 170 is found. The intrinsic quadrupole moment and the deformation parameter are determined. The experimental ratio for the reduced transition probabilities of the $(4^+ \rightarrow 2^+)$ and the $(2^+ \rightarrow 0^+)$ transitions in Er^{166} is compared with that predicted by the asymmetric rotor model. (auth)

2262 $B^-/I.T.$ BRANCHING OF 33 d Te^{129m}. G. Andersson and E. Hageroe (Univ. of Uppsala). Arkiv Fysik, 22: 349-55(1962). (In English)

The relative intensity of beta emission in the decay of 33-day Te^{129m} is determined as (32 ± 12) %, in agreement with a prediction based on beta half-life systematics. This value implies constancy, within the error limits, of M4 matrix elements in odd-mass Te isotopes. (auth)

2263 RETARDED ELECTRIC DIPOLE TRANSITIONS. E. Bashandy and M. S. El-Nesr (Univ. of Uppsala). Arkiv Fysik, 22: 357-69(1962). (In English)

A review and analysis of data on lifetimes of electric dipole transitions in nuclei with $A \geq 16$ is presented. The experimental partial transition probabilities are compared with the theoretical estimates of the single particle model, and retardation factors are reported. A graphical representation for the nuclear matrix elements $|M|^2$ as a function of neutron number is given. The experimental and theoretical data of conversion coefficients for retarded electric dipole transitions are surveyed. Anomalies are observed in some cases. (auth)

2264 CALCULATION OF THE INTERACTION OF FAST PROTONS WITH HEAVY NUCLEI UNDER CONSIDERATION OF THE FISSION PROCESS. V. N. Belyaev and A. N. Murin. At. Energ. (USSR), 13: 317-20(Oct. 1962). (In Russian)

The Monte Carlo method was used for calculating the interaction of the bombarding 135-Mev protons with Bi^{209} nuclei, employing a three-dimensional model of the nucleus. A value of $r_0 = 1.45 \times 10^{-13}$ cm was assumed for the cascade stages. The level density, determined on the basis of the Fermi gas model, was expressed as $\rho(E^*) = C \exp 2\sqrt{a(E^* - \delta)}$, where C is a constant, E^* the excitation energy of the nucleus, a a level parameter of the excited nucleus taken as $1/10$, and δ a parameter involving the shell effect, calculated on the basis of A. Cameron's data (Canadian J. Phys., 36: 1040 (1958) No. 8). The calculations yielded more detailed information concerning the distribution and the value of recoil nuclei pulses. In the case of random bombarding of Bi^{209} with 135-Mev protons, the fission cross section was found to be 95 ± 13 millibarn, agreeing well with data obtained by radiochemical methods. It was found that on the average 10 to 11 neutrons are emitted per fission and that the sum of the mass numbers of the probable fission products lies between 199 and 198. In about 60% of the cases the fission process leads to neutron-deficient Po isotopes with mass numbers ranging from 199 to 202. Using the relative fission probability values derived by I. Dostrovsky et al. (Paper No. 1615, presented by Israel at the Second Geneva Conference, 1958), the values of the excitation energy E^* and of the fission cross section for U and Th were calculated. (TTT)

2265 EXCITATION FUNCTIONS OF SEPARATE LEVELS OF U^{238}, U^{233}, AND Pu^{239} NUCLEI WITH ALLOWANCE FOR THE COMPETITION BETWEEN INELASTIC NEUTRON SCATTERING AND NUCLEAR FISSION PROCESSES. N. O. Bazazyants and I. V. Gordeev. At. Energ. (USSR), 13: 321-6(Oct. 1962). (In Russian)

The excitation functions of U^{238}, U^{233}, and Pu^{239} were calculated on the basis of Niels Bohr's statistical theory (Nature, 137: 344 (1936)); however, the formula used allowed the computation of the energy of the incident neutrons only at the 550 ± 10 kev level. Theoretical and experimental data agree quite well for the U isotopes, but the theoretical value of the fission width is twice as large as the experimentally reported data; this is probably due to the fact that the Breit-Wigner formula cannot be applied in this case. The fission threshold values and the number of transition states obtained were based on both experimental data (R. Stokes et al., Phys. Rev., 115: 1284 (1959)) and theoretical considerations (K. Lee & D. Inglis, Phys. Rev., 108: 774 (1957)). The characteristics of the three target nuclei near the ground state are listed, including for U^{238} and Pu^{239} the excitation cross sections of the individual levels and the total scattering cross section at 0.5 Mev. If the competition between the inelastic neutron scattering and the nuclear fission processes is not taken into account, the above mentioned difference between the theoretical and experimental values is noted. (TTT)

2266 FISSION CROSS SECTIONS OF U^{233}, U^{235}, AND Pu^{239} IN THE NEUTRON ENERGY FROM 0.3 to 2.5 Mev. G. N. Smirenkin, V. G. Nesterov, and I. I. Bondarenko. At. Energ. (USSR), 13: 366-7(Oct. 1962). (In Russian)

Marked irregularities were noted in the energy dependence of the angular anisotropy in the case of the fission of U^{233}, U^{235}, and Pu^{239}. Studies were made for detecting the existence of similar effects in the fission cross sections involving the direct effect of neutrons. The measurements were carried out by means of a Van de Graaff generator in the energy range from 0.3 to 2.5 Mev, making use of the $T(p,n)He^3$ reaction as the source for monochromatic fast neutrons, together with solid tritiated targets, while a double ionization chamber provided with an electronic selector served as the fission fragment detector. The layers containing about 1.5 mg/cm^2 of oxides of U and Pu were placed perpendicularly to the direction of the proton beam. The fission cross functions of the three isotopes represent the basic features of the energy dependence of fissionability, determined by the (d,p) reaction (V. G. Nesterov et al., Atomn. Energ., 11: 248 (1961) No. 3). A clear-cut correlation between the fission cross section and angular anisotropy could be observed only for U^{233} and Pu^{239} in the energy range of <1.5 Mev and not at all for U^{235}. (TTT)

2267 MONOCHROMATIC NEUTRON ABSORPTION CROSS SECTION FOR U^{235} AT ENERGIES RANGING FROM 0.02 TO 2 ev. V. F. Gerasimov and V. S. Zenkevich. At. Energ. (USSR), 13: 368-70(Oct. 1962). (In Russian)

The energy dependence of the absorption cross section of U^{235} was determined by means of a chopper installed in the horizontal beam of the RFT reactor, using a flight distance of 17.24 m at a maximum resolution of 1.4 μsec/m. A spherical chamber, in the center of which the sample was placed, was used for detecting the neutrons in the BF_3 gas filling the space between the double spherical walls. A positive potential of 3 kv was applied on the inner sphere serving as the selector electrode. Cylindrical, 28-mm-diam. and 0.5-, 2-, and 8-mm-thick U samples containing 90.3% U^{235} were used for the measurements, while Zr specimens containing B served for the calibration of the experimental apparatus. The character of the energy dependence curve of σ_c was found to be quite similar to that of σ_t; the actual value of σ_c at the thermal point $E_n = 0.0253$ ev was found to be 670 barn, agreeing well with data reported by K. Case et al. ("Introduction to the Theory of Neutron Diffusion," Los Alamos, 1953). The value of $(\sigma_t - \sigma_c)$ obtained from these curves varies within wide limits but does

not disagree with reported values of the scattering cross section of U^{235}; it tends to increase in the resonance level range, at 2.04 and 1.13 ev, probably because of resonance scattering. (TTT)

2268 CALCULATION OF THE NEUTRON CROSS SECTIONS OF U^{238} FROM THE OPTICAL MODEL OF THE NUCLEUS. V. E. Kolesov and V. S. Stavinskii. At. Energ. (USSR), 13: 371-3(Oct. 1962). (In Russian)

The optical model, involving the diffuse complex potential, allows definition of σ_t, the total cross section of the interaction of the neutrons with nuclei; it may be used also for calculating the inelastic scattering and radiative capture cross sections σ_{in} and $\sigma_{n\gamma}$. This method was used for determining the energy dependence of the various neutron cross sections, which make up the total cross section of a given nucleus and the transport cross section σ_{tr} for the U^{238} nucleus. The Woods-Saxon type potentials (Phys. Rev., 95: 577 (1954)) were computed without considering the spin-orbital interactions. The total, transport, and formation cross sections were measured within an energy range from 40 kev to 16 Mev. The excitation scheme of U^{238} was taken to agree with that of Pu^{238}. Satisfactory agreement was obtained with data reported by L. Kranberg and J. Levin (Phys. Rev., 109: 2063 (1958)) for both the total inelastic scattering cross section and the excitation functions of the first two levels: 2^+ (44 kev) and 4^+ (146 kev). The data concerning the inelastic scattering cross sections corresponding to the excitation of the levels with an average energy of about 730 kev in the cited work agree with the total excitation cross section for the 1^- (605 kev) and 3^- (656 kev) levels. Use of the optical model is thus considered justified. (TTT)

2269 NEUTRON PHYSICS EXPERIMENTS AT THE SACLAY 28-Mev ELECTRON LINEAR ACCELERATOR. J. Julien, P. Ribon, C. Corge, A. Michaudon, F. Netter, and D. Paya. Bull. Inform. Sci. Tech. (Paris), No. 60, 60-73 (Apr. 1962). (In French)

The time-of-flight method for neutron cross section measurements is described, and its principal limitations (experimental resolution and thermal perturbation in the nuclei in the sample) are given. Some examples of the measurements made and the results obtained for total and fission cross sections and capture γ rays are discussed. (auth)

2270 MEASUREMENT OF THE γ POLARIZATION FOLLOWING THE β DECAY OF A^{41}. Marc Chabre and Pierre Depommier (Université, Grenoble, France and Centre d'Études Nucléaires, Grenoble, France). Compt. Rend., 255: 503-5(July 16, 1962). (In French)

The circularly polarized $\beta-\gamma$ correlation in Ar^{41} was measured, and the value $A = 0.09 \pm 0.05$ was found. This result is compatible with a Fermi matrix element $M_f = 0$. (tr-auth)

2271 ELASTIC SCATTERING OF FAST PROTONS BY DEFORMED NUCLEUS. S. K. Dutta and N. C. Sil (Indian Association for the Cultivation of Science, Jadavpur, Calcutta). Indian J. Phys., 36: 408-14(Aug. 1962).

The method of Born approximation is used to calculate the elastic scattering cross section of fast protons by a prolate spheroidal nucleus; the nuclear potential is represented by a complex rectangular well of constant depth and sharp cut-off, and the Coulomb potential is taken to be that produced by a uniform distribution of protons within the nucleus. Numerical results for the Ta nucleus are in fair agreement with experimental data. (auth)

2272 MÖSSBAUER SCATTERING OF LOW ENERGY GAMMA-RAYS. B. S. Sood (Punjab Univ., Chandigarh, India). Indian J. Phys., 36: 419-21(Aug. 1962).

The Mössbauer scattering cross section for 14.4-kev gamma rays in iron-57 is found to be 142 ± 30 barns; this result agrees with theory if the levels involved in the scattering are assumed to be split. (auth)

2273 EXCITATION FUNCTIONS OF THE (p,pn) AND (p,2p) REACTIONS ON Te^{130} AT 60-233 Mev. Dean W. Nauer and Edwin O. Wiig (Univ. of Rochester, N. Y.). J. Am. Chem. Soc., 84: 4059-70(Nov. 5, 1962).

The cross sections of the reactions $Te^{130}(p,pn)Te^{129m}$, $Te^{130}(p,pn)Te^{129g}$, and $Te^{130}(p,2p)Sb^{129}$ were determined for protons of 60, 120, 180, and 233 Mev energy. The observed yields of Te^{129} and Sb^{129} were compared with those predicted by interpolation of Monte Carlo cascade calculations on Ru^{100} and Ce^{140} at 83, 238, and 368 Mev followed by evaporation calculations based on data for Ce^{142}. There was good agreement in shape and absolute magnitude for the (p,pn) excitation function but poor agreement for the (p,2p) reaction. In the (p,pn) reaction the low-spin Te^{129g} isomer was found to be favored over high-spin Te^{129m}. (auth)

2274 DETERMINATION OF THE INTENSITIES OF PROTON BEAMS FROM 40 TO 150 Mev. C. Brun, M. Lefort, and X. Tarrago (Faculté des Sciences, Paris). J. Phys. Radium, 23: 371-6(June 1962). (In French)

The intensity of a proton beam may be monitored by well known nuclear reactions if the absolute cross sections have been determined with a good accuracy. Results were obtained on excitation functions between 40 and 150 Mev for four nuclear reactions on graphite and aluminium targets. Cross sections for the formation of radionuclides C^{11} and Be^7 from C^{12} and Na^{24} and Na^{22} from Al^{27}, were measured in the limits of 5% of accuracy. The proposed values for 150 Mev protons are respectively 45 ± 2 mb, 10.5 ± 0.5 mb, 9.6 ± 0.4 mb and 18 ± 1 mb. (auth)

2275 THE HALF-LIFE OF He^6. J. K. Bienlein and Frances Pleasonton (Oak Ridge National Lab., Tenn. and Universität, Erlangen, Ger.). Nucl. Phys., 37: 529-34 (Sept. 1962). (In English)

The decay of He^6 was measured, with a plastic scintillation counter, over a period of 10 half lives. The data were obtained by photographing two scalers, one of which registered the β counts while the other, operating on a 60-cps signal, served as the clock. After suitable corrections for background, dead-time of the counting system, and pulse height dependence on counting rate, 34 separate runs were combined. A least squares fit to the data gave a value of $T_{1/2} = (0.797 \pm 0.003)$ sec. (auth)

2276 ELASTIC SCATTERING OF PROTONS BY CARBON. G. G. Shute, D. Robson, V. R. McKenna, and A. T. Bertztiss (Univ. of Melbourne). Nucl. Phys., 37: 535-53(Sept. 1962). (In English)

The energy levels of N^{13} are investigated by the elastic scattering of 5- to 11.5-Mev protons from C^{12}. The low-lying levels are analyzed using the conventional hard-sphere potential to describe potential scattering and Breit-Wigner forms for the resonance levels. A phase-shift analysis is carried out at low energies and accurate phases are obtained. At higher energies the hard-sphere phases are replaced by optical-model type phases, which are required to describe the effects of non-resonant inelastic scattering. Definite spin and parity assignments are found for several of the levels obtained experimentally. A comparison of the observed level scheme of N^{13} is made with shell-model predictions, and agreement is observed for most of the levels. (auth)

2277 EFFECTS OF BLOCKING ON THE LEVEL SPACINGS OF ODD-MASS DEFORMED NUCLEI. S. Wahl-

born (NORDITA, Copenhagen and Royal Inst. of Tech., Stockholm). Nucl. Phys., 37: 554-84(Sept. 1962). (In English)

The systematic effect of pairing correlations on the low-lying intrinsic levels of odd-mass deformed nuclei is calculated. The calculation is of the blocking type, i.e., a re-adjustment of the wave function is performed for each level occupied by the odd particle. It is possible to find a simple, valid description of the effect of blocking. The mean energies of the first few excited states can also be estimated by averaging over the distribution of single-particle levels. The result of this estimate is compared with experimental data for the nuclear regions $150 < A < 190$ and $A > 225$. It turns out that a consistent interpretation of the data cannot be obtained by the estimate, if pairing correlations and blocking are not taken into account, whereas the blocking calculation in general leads to agreement with the data. (auth)

2278 HEISENBERG COMPONENTS IN TWO-BODY FORCES AND OPTICAL MODEL POTENTIAL. P. C. Sood (Panjab Univ., Chandigarh, India). Nucl. Phys., 37: 624-31(Sept. 1962). (In English)

Evidence from the static and velocity-dependent potential wells adjusted to give experimental nucleon separation energies; optical model analysis of nucleon-nuclear scattering; and the interpretation of nuclear symmetry energy in relation to the nuclear potential are examined to establish the validity of the equation $V_{p,n} = V_0 \pm ((N-Z)/4A)V_1$, where V_p represents the average potential acting on a proton and V_n that acting on a neutron (the upper sign is for protons and the lower one for neutrons). The suggestion that this form for the potential results from the presence of Heisenberg (or charge exchange) forces in the two-body interaction is critically examined. The coefficient V_1 of the isobaric spin dependent term is determined. An alternative explanation based on the spin dependence of nuclear forces is also discussed. (auth)

2279 OPTICAL MODEL AND DISTORTED WAVE ANALYSIS OF (p,n) CROSS-SECTIONS. P. E. Hodgson and J. R. Rook (Clarendon Lab., Oxford). Nucl. Phys., 37: 632-46(Sept. 1962). (In English)

The general theory of the (p,n) reaction is formulated, and two approximate methods of solving the resulting coupled differential equations are investigated. The first method is equivalent to the introduction of an isobaric-spin-dependent interaction into the optical potential, and the results show that the (p,n) cross section is proportional to the square of the strength of this term and similar in general shape to the (p,p) elastic scattering cross section. The effect of the isotopic-spin-dependent potential on the (p,p) cross section is found to be negligible. The second method is the distorted wave Born approximation, and the results show that the spin of the target nucleus can have an effect. When the spin of the target nucleus is neglected, the results of the two methods are qualitatively the same. (auth)

2280 ON THE ROLE OF ONE-PION EXCHANGE IN NUCLEAR STRUCTURE PROBLEMS. J. Dabrowski (Univ. of Copenhagen). Nucl. Phys., 37: 647-51(Sept. 1962). (In English)

The inapplicability of the one-pion-exchange (OPE) approximation in nuclear structure problems is discussed. The dominant contribution of the OPE to the optical potential for nucleon-nucleus scattering is shown to come from the short range part of the two-body interaction. (auth)

2281 PAIRING AND QUADRUPOLE INTERACTIONS IN CONFIGURATIONS j^n. S. I. Drozdov (Kurchatov Inst. for Atomic Energy, Academy of Sciences, Moscow and Univ. of Copenhagen). Nucl. Phys., 37: 652-62(Sept. 1962). (In English)

An attempt is made to observe the development of collective properties of nuclei, by the exact diagonalization of the Hamiltonian with pairing and quadrupole interactions, for some simple configurations of like nucleons. The results of calculations of energy levels, transition probabilities, etc. are compared with the predictions of the rotational and vibrational models. A comparison is made with the aligned coupling scheme. (auth)

2282 ISOBARIC SPIN PURITY AND ISOBARIC CORRESPONDENCE BETWEEN NUCLEAR STATES IN THE HEAVIER NUCLEI. A. M. Lane and J. M. Soper (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Phys., 37: 663-78(Sept. 1962). (In English)

A study is made of the properties of isobaric states, as revealed by observations of (p,n) reactions. It is suggested that while the data demonstrate the existence of correspondence between states of adjacent isobars, they do not directly indicate the degree of purity of isobaric spin in the target nucleus. On theoretical grounds, it is argued that isobaric spin is a good quantum number in heavy nuclei, and is also a useless one since its degree of purity cannot be directly checked by experiment. Estimates made of the width of the observed isobaric states suggest that they are roughly independent of mass-number A for $A > 80$, and are of order 0.2 Mev. This means that the states should be observable in even the heaviest nuclei. (auth)

2283 HYPERFINE INTERACTIONS OF THE 2^+ STATE IN Dy^{160}. S. G. Cohen and G. Gilat (Hebrew Univ., Jerusalem). Nucl. Phys., 38: 1-10(Oct. 1962). (In English)

The hyperfine interaction of the 2^+ state in Dy^{160} situated in ferrimagnetic dysprosium iron garnet (DIG) is studied at room temperature by measuring the perturbation of the angular correlation of γ cascades passing through this state. A large rotation of the angular correlation pattern is observed when the domains are aligned in an external magnetic field perpendicular to the plane of the counters. A longitudinal external field is used to decouple the effectively static part of the hyperfine interaction and isolate the time-dependent interactions. The quantity $g\mu_n H_{eff}/h$ is found to be (160 ± 50) Mc. Assuming H_{eff} equals 6.0×10^5 Oe from recoil-free experiments, the g factor of the 2^+ state is found to be 0.32 ± 0.10. The relaxation times characterizing the time-dependent perturbation are estimated to be $(1.5 \pm 0.5) \times 10^{-12}$ sec for DIG and $(0.9 \pm 0.3) \times 10^{-12}$ sec for aqueous solution of $TbCl_3$. (auth)

2284 THE $Li^6(d,\alpha)\alpha$ REACTION. J. M. F. Jeronymo, G. S. Mani, F. Picard, and A. Sadeghi (Centre d'Etudes Nucléaires, Saclay, France). Nucl. Phys., 38: 11-17(Oct. 1962). (In English)

The $Li^6(d,\alpha)\alpha$ reaction is studied up to 5 Mev deuteron energy. A level in Be^8 at 25.3-Mev excitation is observed having probably $J = 2^+$ and $T = 0$. (auth)

2285 $C^{12}(d,p\gamma)$ PROTON-GAMMA ANGULAR CORRELATIONS. N. R. Fletcher, D. R. Tilley, and R. M. Williamson (Duke Univ., Durham, N. C.). Nucl. Phys., 38: 18-32 (Oct. 1962). (In English)

The $C^{12}(d,p\gamma)C^{13}$ angular correlations through the second and third excited states of C^{13} are measured at reaction angles near the stripping maximum with bombarding energies of 2.80, 3.23, and 3.70 Mev. Both correlations have the angular symmetries of direct reactions. The energy dependence of these correlations, which involve negative Q value reactions, is much less than that of positive-Q-value

(d,pγ) reactions in this energy region. The p_2-γ angular correlation is measured in the azimuthal plane and at several different proton angles in the reaction plane to determine the extent of applicability of the distorted-wave stripping theory. The stripping character of both the $C^{12}(d,p_2)$ and $C^{12}(d,p_3)$ reactions appears to be modified by compound nucleus formation. Tentative multipole mixtures assigned are $\Gamma(E2)/\Gamma_\gamma \lesssim 5\%$ for the 3.68-Mev radiation and $\Gamma(E3)/\Gamma_\gamma \lesssim 2\%$ for the 3.85-Mev radiation. (auth)

2286 NUCLEAR LEVELS NEAR THRESHOLDS. F. C. Barker and P. B. Treacy (Australian National Univ., Canberra). Nucl. Phys., 38: 33-49(Oct. 1962). (In English)

Cross sections for reactions proceeding through unstable states of nuclei may be expressed in terms of a density-of-states function. A certain form $\rho^{(1)}$ of this function is compared with a suggested form $\rho^{(2)}$ and it is shown that cross sections involving levels of the nuclei Be^8, Be^9, and B^9 that can be interpreted in terms of $\rho^{(2)}$ can be satisfactorily explained on the basis of $\rho^{(1)}$. Certain inconsistencies in the use of $\rho^{(2)}$ are pointed out, in addition to a property which makes it unsuitable for general use. From the form of $\rho^{(1)}$ it is concluded that an anomalous peak, or "ghost," may be associated with an isolated level sufficiently close to a threshold, and that such a ghost could be mistakenly identified as a separate level. A discussion of ghosts is given, and related to levels in some light nuclei. (auth)

2287 STUDY OF THE CADMIUM ISOTOPES VI. BETA AND GAMMA RAY SPECTROSCOPY OF Ag^{112}. Hikaru Inoue, Jian-Zhi Ruan, Satoshi Yasukawa, and Yasukazu Yoshizawa (Osaka Univ.). Nucl. Phys., 38: 50-62(Oct. 1962). (In English)

Beta and gamma rays emitted from Ag^{112} are investigated using a magnetic beta-ray spectrometer and scintillation spectrometers. The half life is determined to be 3.14 ± 0.05 hr. Maximum energies and relative intensities of beta rays are 3.94 ± 0.04 Mev (54%), 3.35 ± 0.08 Mev (22%), and 1.96 ± 0.10 Mev (10%). Internal conversion electrons corresponding to 0.610-, 0.621-, 0.648-, and 0.689-Mev gamma rays and other uncertain conversion electrons are found. In single, summing peak, gamma-gamma coincidence, and beta-gamma coincidence spectra, twenty-six gamma rays are observed. A decay scheme is constructed. (auth)

2288 LOWER LEVELS OF O^{17} AND F^{17} IN THE α-MODEL OF THE NUCLEUS. S. Matthies, V. G. Neudachin, and Yu. F. Smirnov (Moscow State Univ.). Nucl. Phys., 38: 63-73(Oct. 1962). (In English)

A method is presented for calculating one-particle states in the α-model by using a nonspherical potential. The spectrum of the lower levels of O^{17} and F^{17} is calculated in the weak coupling scheme, taking into account the interaction of the motion of the particle with the non-sphericity of the core and with vibrations. With certain values of the parameters used in the calculation namely the deformation parameter and the particle-vibration coupling constant, the results agree with experiment. The lower levels of negative parity of the O^{17} or F^{17} system have small reduced widths and are rotational-vibrational states constructed on the single-particle orbits of the outer nucleon 1 d and 2s with small admixtures of 1f and 2p. The calculation shows that the quadrupole moment of O^{17} and the lifetime of the level $\frac{1}{2}^+$ are almost entirely determined by the influence of the lower 2+ level of O^{16} with an energy 6.91 Mev. (auth)

2289 EFFECTIVE RANGE THEORY AND VELOCITY DEPENDENT POTENTIALS. K. Appel and E. Werner (Universität, Saarbrücken, Saar., Ger.). Nucl. Phys., 38: 74-80(Oct. 1962). (In English)

For three different types of the radial dependence of the potential, namely square well, exponential, and Yukawa, the shape-independent potential parameters of a velocity-dependent potential are evaluated as a function of the strength parameter of the non-static part of the potential. (auth)

2290 SOME ENERGY LEVEL DETERMINATIONS OF O^{18} AND O^{20}. S. Hinds, H. Marchant, and R. Middleton (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Nucl. Phys., 38: 81-8(Oct. 1962). (In English)

Some energy levels of O^{18} and O^{20} are determined from studies of the $O^{16}(t,p)O^{18}$, $F^{19}(t,\alpha)O^{18}$, and $O^{18}(t,p)O^{20}$ reactions. In all cases tritons of about 6 Mev are used and the emitted protons or alpha particles are analyzed in a broad-range magnetic spectrograph. Twenty-six states are observed in O^{18} below an excitation energy of 8.64 Mev, and eleven states in O^{20} below 5.83 Mev. The Q-value of the $O^{18}(t,p)O^{20}$ reaction is measured to be 3.076 ± 0.010 Mev and is consistent with a mass excess for O^{20} of 3.802 Mev (refer to C^{12} scale). (auth)

2291 STUDIES OF (p,n) REACTIONS WITH A He^3 ION CHAMBER AND SOME NEW LEVELS IN Ne^{19}. J. M. Freeman and D. West (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Phys., 38: 89-105(Oct. 1962). (In English)

An ionization chamber, containing He^3 and krypton to a total pressure of 6.6 atm, is developed for the measurement of fast neutron spectra with an energy resolution varying between 40 and 70 kev for neutrons from a few hundred kev to a few Mev. Some details are given of the properties of this instrument and of the methods evolved for the accurate measurements of Q values of (p,n) reactions. For the Na^{23} (p,n) Mg^{23} reaction, Q values of −4.835 ± 0.003 and −5.288 ± 0.004 Mev are obtained for the ground and first excited state transitions, respectively. In studies of the $F^{19}(p,n)Ne^{19}$ reaction, the third, fourth, and fifth excited states of Ne^{19} are identified at excitation energies of 1.506 ± 0.005, 1.538 ± 0.004, and 1.612 ± 0.005 Mev. (auth)

2292 THE DECAY OF Co^{58}. D. MacArthur, R. Goodman, A. Artna, and M. W. Johns (McMaster Univ., Hamilton, Ont.). Nucl. Phys., 38: 106-13(Oct. 1962). (In English)

Magnetic spectrometer measurements and gamma-gamma coincidence experiments are carried out to show that the energies of the gamma rays following the decay of Co^{58} are 810.48 ± 0.10, 865 ± 1, and 1673 ± 10 kev, with intensities 100, 1.20 ± 0.06, and 0.66 ± 0.05% respectively. The γ-γ angular correlation pattern for the 810-865 kev cascade leads to the interpretation of the 865-kev transition as M1 + E2. The value found for the branching ratio for the 865-kev transition, when applied to data on the alignment of Co^{58}, leads to a value of 0.8 ± 0.4% for the Fermi admixture in the beta transition to the 810-kev state of Fe^{58}. (auth)

2293 A STUDY OF THE $B^{10}(d,p)B^{11}$ REACTION. S. Hinds and R. Middleton (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Nucl. Phys., 38: 114-20(Oct. 1962). (In English)

Angular distributions of the proton groups from the $B^{10}(d,p)B^{11}$ reaction leading to the ground and first eleven excited states of B^{11} are measured using a multi-channel magnetic spectrograph with an angular range of 5 to 175°. The incident deuteron energy is 10.10 Mev. The more intense distributions are fitted with plane-wave stripping curves, which enable some l-value assignments to be made and some absolute reduced widths to be extracted. (auth)

2294 E2 INTERNAL CONVERSION COEFFICIENTS OF $2^+ \rightarrow 0^+$ TRANSITIONS FROM THE DECAY OF ^{170}Tm, ^{196}Au AND ^{200}Tl. J. F. W. Jansen, S. Hultberg, P. F. A.

Goudsmit, and A. H. Wapstra (Instituut voor Kernphysich Onderzoek, Amsterdam). Nucl. Phys., 38: 121-31(Oct. 1962). (In English)

The K conversion coefficients of pure E2 transitions in three even nuclei are measured with the internal-external (IEC) method, using an iron-free double-focusing beta-ray spectrometer. The α_K's of the 356-kev transition in Pt^{196} and the 368-kev transition in Hg^{200} are in agreement with theory. The result for the 84-kev transition in Yb^{170} is 15% above the theoretical value. The latter α_K is also used for the determination of L photoelectric cross sections in uranium at 84 kev using the IEC method in the reverse sense. A number of E2 conversion coefficients measured by the internal-external method are tabulated. (auth)

2295 ON THE THEORY OF REACTIONS WITH PRODUCTION OF THREE LOW-ENERGY PARTICLES. V. V. Anisovich, A. A. Anselm, and V. N. Gribov (Leningrad Inst. of Physics and Tech.). Nucl. Phys., 38: 132-45(Oct. 1962). (In English)

The structure of the amplitude of production of three low-energy particles is discussed (the momenta of the particles produced being small compared with $1/r_0$, where r_0 is the interaction radius). Results are given for terms linear and quadratic with respect to the momenta. Detailed consideration is given to the terms cubic with respect to the momenta of the particles produced, in the case of neutral particles and τ-decay. These terms are a simple polynomial of the third degree with respect to the momenta, with coefficients depending only on the scattering amplitude of two particles. Comparison of the respective formulae with experimental data makes possible in principle the determination of amplitudes for scattering of unstable particles on each other (π-meson on π-meson, for example). (auth)

2296 WIDTH OF THE FIRST EXCITED STATE OF Sn^{116}. N. Lingappa (Tate Inst. of Fundamental Research, Bombay), E. Kondaiah, C. Badrinathan, M. D. Deshpande, and M. Balakrishnan. Nucl. Phys., 38: 146-53(Oct. 1962). (In English)

The width of the 1.27-Mev level of Sn^{116} is measured by studying nuclear resonance scattering of the de-excitation gamma rays. The level width is found to be $(9.4 \pm 1.6) \times 10^{-4}$ ev; this gives a half life of $(4.9 \pm 0.9) \times 10^{-13}$ sec for the 1.27-Mev level, in agreement with Coulomb-excitation results. (auth)

2297 VARIATIONAL APPROACH TO COLLECTIVE MOTION. R. E. Peierls (Univ. of Birmingham, Eng.) and D. J. Thouless. Nucl. Phys., 38: 154-76(Oct. 1962). (In English)

The translational (rotational) motion of a nucleus is described in terms of a linear combination of wave functions, each of which is generated from the Hartree-Fock wave function of the shell model, including deformation, by a linear (angular) displacement and a linear (angular) velocity. The angular velocity is represented in the same way as in the work of Thouless (Nuclear Phys. 21: 225(1960)), and, if this representation is based on a fully self-consistent treatment the moment of inertia found for rotation about a fixed axis, is the same as that found by Thouless. The three-dimensional case is treated by the same method. The method can be regarded as a technique for finding, in the translational problem, exactly the correct kinetic energy of the center-of-mass motion. (auth)

2298 MANGANESE BATH MEASUREMENTS OF η OF Pu^{239}. R. L. Macklin, G. DeSaussure, J. D. Kington, and W. S. Lyon (Oak Ridge National Lab., Tenn.). Nuclear Sci. and Eng., 14: 101-3(Sept. 1962).

Additional data on the manganese bath measurement of η for Pu^{239} are reported. The technique of measurement was described in Nuclear Sci. and Eng. 8: 210-220(1960) and the data is presented in identical notation. Data used for the variation of the ratio of the total absorption to the fission cross section with energy are shown. (W.D.M.)

2299 NUCLEAR RECOIL IN SOLIDS. II. THE REACTION $Al^{27}(n,p)Mg^{27}$. K. E. Zimen and D. Ertel (Hahn-Meitner-Institut für Kernforschung, Berlin). Nukleonik, 4: 231-2(Aug. 1962). (In German)

From the escape probability measured by means of capture foils, the mean recoil range of Mg^{27} formed by (n,p) processes in aluminum was determined as $\bar{R} = (0.455 \pm 0.007) \times 10^{-4}$ cm. This value is valid for the neutron spectrum of the BER. For the range of recoil atoms with 1 Mev energy, the value $R_1 = 2.34 \times 10^{-4}$ cm was obtained from a relationship developed by Biersack and Zimen. (tr-auth)

2300 ENERGY LEVELS OF Zr^{92} AND Zr^{93}. Y. R. Waghmare (Physical Research Lab., Ahmedabad, India). Physica, 28: 957-8(Sept. 1962). (In English)

Shell-model calculations of the energies and spins of the states of Zr^{92} up to an excitation energy of about 4 Mev are carried out, on the basis of the addition of two neutrons to the Zr^{90} nucleus. The calculated values are compared with experimental results. The implications of the calculated energy values for Zr^{92}, regarding energy levels in Zr^{93}, are investigated in the jj coupling scheme. (T.F.H.)

2301 ON THE NUCLEAR QUADRUPOLE RESONANCE SPECTRUM OF $Sb^{121,123}$ IN POLYCRYSTALLINE SbI_3. I. A. Safin (Inst. of Physics and Tech., Kazan' Branch, Academy of Sciences, USSR). Soviet Phys.-Solid State (English Transl.), 4: 1005(Nov. 1962).

The nuclear quadrupole resonance spectra of Sb^{121} and Sb^{123} in SbI_3 are observed at 77°K and 20 to 150 Mc. A 25.40-Mc transition is observed in Sb^{121} that is concluded to proceed from a state with $|m| = 5/2$ to one with $|m| = 3/2$. A 23.10-Mc transition is also observed in Sb^{123} that is concluded to proceed from $|m| = 7/2$ to $|m| = 5/2$. From the ratio of these two frequencies, and the ratio of the quadrupole coupling constants of the two nuclei, it is concluded that Sb^{121} has a quadrupole coupling constant of 84.67-Mc with an asymmetry <0.01. Measurements are made by spin-echo methods. (T.F.H.)

2302 ATOMIC WEIGHT SCALE BASED ON $^{12}C = 12$ AND THE NEW ATOMIC WEIGHT TABLES OF THE ELEMENTS AND OF THE NUCLIDES. V. A. Kravtsov. Usp. Fiz. Nauk, 78: 65-92(Sept. 1962). (In Russian)

At the start of the last century Dalton proposed the use of the weight of H as the unit of atomic weights; later Berzelius suggested O as the reference weight. The International Commission on Atomic Weights chose 1/16 of the weight of O as the unit at the start of this century; this was further refined later by Aston, setting $O^{16} = 16$. Subsequent discovery of the O^{17} and O^{18} isotopes resulted in the creation of separate "chemical" atomic weight and "physical" atomic mass systems; the "chemical" unit was equal 1.000275 × "physical" unit. The problem was repeatedly discussed by the International Union of Pure and Applied Chemistry and the International Union of Pure and Applied Physics. Many proposals were made, taking into account all the nuclides, isotopes, isobars, and istones alike. Gamow and Bethe proposed $He^4 = 4$ as reference; Selinov and Dole $F^{19} = 19$; Nier and Olander $C^{12} = 12$; the latter considered also $O^{18} = 18$. R. Birge supported the C^{12} proposal. This mass unit differs from the chemical system's unit only by 0.0043%. Both the IUPAC and the IUPAP recommended adoption of the new system, the unit u of which 1/12 of the mass of the nuclide C^{12}. The following factors indicate the

correlations: 1 u = (931441 ± 10) kev = 1.000317917 ± 0.000000017 "physical" (O^{16} = 16) unit = 1.000043 ± 0.000012 "chemical" (O = 16) unit. The tables calculated by L. Kö-nig, J. Mattauch, and A. Wapstra (Nucl. Phys. 31: 18(1962)) are presented. (TTT)

2303 APPLICATION OF COINCIDENCE METHOD IN STUDIES OF Ce^{144} DECAY SCHEME. Ts. B. Vasilev, N. V. Forafontov, and V. S. Shpinel. Vestn. Mosk. Univ., Ser. III, No. 3, 3-16(May-June 1962). (In Russian)

The Ce^{144} decay scheme was studied using a β spectrometer and a $\beta(\gamma)$ luminescence spectrometer in coincidence. The results obtained for β-e, e-e, and e-γ coincidences are in agreement with decay schemes found in published literature. An additional level at 147 kev was introduced into the scheme. (tr-auth)

2304 PHOTOPROTONS FROM TUNGSTEN. V. G. Shevchenko and B. A. Yur'ev. Vestn. Mosk. Univ., Ser. III, No. 3, 90-3(May-June 1962). (In Russian)

A 35-Mev betatron with a 24.6 mg/cm^2 foil of tungsten with less than 0.05% impurities was used for measuring the angular and energy distributions and yields of photoprotons at a maximum γ and bremsstrahlung energies of 22.5 and 33.5 Mev. The photoproton yields at E_{max} = 22.5 and 33.5 Mev were 2.6×10^4 and 6.8×10^4, respectively. Thus the results show that in (γ,p) reactions the W cross section maximum is found at E_γ = 22.5 Mev and the γ absorption is basically quadrupole in character. (R.V.J.)

2305 MEASUREMENT OF THE HALF LIFE OF THE 87-kev LEVEL OF Dy^{160}. F. W. Richter and D. Wiegandt (Universität Marburg/Lahn, Ger.). Z. Naturforsch., 17a: 638-40(Aug. 1962). (In German)

Measurement of the half life of the first excited state of Dy^{160} gave a value of $T_{1/2}$ = 2.24 ± 0.06 nsec, instead of the 1.8 ± 0.2 nsec given by McGowan (Phys. Rev. 85: 142(1952)). This value is in good agreement with Coulomb excitation data. (auth)

2306 CALCULATION OF THE SURFACE OF NUCLEAR MATTER USING SPECIAL SINGLE-PARTICLE WAVE FUNCTIONS. Franz Lanzl (Universität Göttingen, Ger.). Z. Naturforsch., 17a: 640-9(Aug. 1962). (In German)

Using a Yukawa interaction between the nucleons, the volume energy per particle and the specific surface energy are calculated. These expressions assume a very simple form for a zero range interaction. The space parts of the orthogonal single particle wave functions applied are products of plane waves and a momentum independent function which brings about the decrease in density within the surface layer. First the volume energy per particle as a function of the density in the interior of nuclear matter is minimized. The interaction parameters are so selected that the values of the volume energy per particle and the density at the minimum agree with the experimental data. Then the surface energy as a function of the surface thickness is minimized. The values of the surface energy and the surface thickness in the minimum are compared with the empirical data. They are found to be of the right order of magnitude. (auth)

2307 A NEW HOLMIUM ACTIVITY WITH 11.5-MINUTE HALF LIFE. H. Schepers (Universität Bonn, Ger.). Z. Naturforsch., 17a: 695-6(Aug. 1962). (In German)

After irradiation of terbium oxide with 65-Mev α particles, a new activity with a half life of 11.5 ± 0.5 min was observed with a complex γ spectrum. The activity was assigned to isotope Ho^{158}, produced by $Tb^{159}(\alpha,5n)Ho^{158}$. The irradiation conditions were briefly described, and the atomic number was determined by separation of the neighboring rare earths in an ion exchanger. A second activity of 29 ± 2 min was detected and assigned to the isomer Ho^{158m}. (J.S.R.)

2308 THE DECAY OF Nb^{94m}. P. Kilian, H. Langhoff, and A. Flammersfeld (Universitat, Gottingen, Ger.). Z. Physik, 169: 23-31(1962). (In German)

By the use of scintillation spectrometers and coincidence techniques, the decay of Nb^{94m} was investigated. The K-shell conversion coefficient of the 41.5 kev isomeric transition was found to be 570 ± 100 indicating a M3 transition. The maximum energy of the β decay to the 0.87 Mev level of Mo^{94} is (1.15 ± 0.03) Mev occurring with a frequency of $(4.5 \pm 0.7) \times 10^{-3}$ per disintegration. Another β decay to the 1.57 Mev level was found to be $(4.0 \pm 1.3) \times 10^{-5}$. From this the parities and spins of the levels involved in the decay of Nb^{94m} are determined. (auth)

2309 HYPERFINE STRUCTURE OF THE NUCLEAR LEVEL IN ION CRYSTALS OF THE RARE EARTHS. Hermann Eicher (Technische Hochschule, Munich). Z. Physik, 169: 178-97(1962). (In German)

The hfs of nuclear levels of the rare earths was investigated when the energy state of the paramagnetic shell is modified by the electrostatic crystalline fields. For a quantitative calculation, the magnetic dipole and the electric quadrupole operators, which describe in the first approximation the interaction of the nucleus with the electrons, were derived. Under the assumption of strong coupling, the number of energy levels for the 32 crystalline classes were calculated. At temperatures of over 20°K small spin lattice relaxation times, which occur through the energy exchange between the paramagnetic ions and the crystalline lattice, of $\tau < 10^{-10}$sec were expected. For these small relaxation times one obtains only the "incoherent" fraction of the nucleus-electron interaction since the non-diagonal matrix elements of the secular equations average out in property phase relations. The magnetic field at the nuclear sites is zero for this limiting case, whereas an average electric field gradient of the electron shell remains. The field gradient is temperature independent and disappears at high temperature (kT is large in comparison with the crystal field splitting of about 300 cm^{-1}). The results explain the Mössbauer spectra of the oxides of Dy^{161}, Er^{166}, Tm^{169}, and Yb^{170}. With the exception of Er_2O_3, whose spectrum was measured at 20°K, the hfs splitting is explained by a mean electric field gradient at the nuclear site. The nuclear level of Er^{166} splits, on the other hand, primarily through a magnetic dipole interaction. The gyromagnetic behavior of the 80.6-kev rotational level is calculated at g_R = +0.21. In the calculation, the polarization of the s-electrons was neglected by the unfilled 4f shell. A possible weakening of the magnetic dipole interaction from the relaxation effect also remains unconsidered. (tr-auth)

2310 THE HALF-LIFE OF THE 1.49-Mev LEVEL IN Co^{57}. Chr. v. Faber du Faur and K. H. Lindenberger (Universität, Heidelberg, Ger.). Z. Physik, 169: 286-8 (Aug. 1962). (In German)

For the half life of the 1.49 Mev state in Co^{57} an upper limit of 3.0×10^{-10} sec was found. (auth)

2311 INTERNAL CONVERSION COEFFICIENTS OF THE TRANSITIONS IN Tm^{169}. Z. Grabowski, J. E. Thun, and B. Lindstroem (Univ. of Uppsala). Z. Physik, 169: 303-14(Aug. 1962). (In English)

The conversion electron spectrum of Tm^{169} was measured by an iron-yoke double focusing spectrometer. Gamma-ray energies and gamma-ray intensities were measured by a

bent crystal spectrometer. Conversion coefficients and conversion ratios were determined from the electron and gamma intensities. The conversion process of the delayed M 1 transitions of 177 kev and 198 kev was found to be normal, in agreement with our earlier directional correlation results. No penetration effects were found in the conversion process of the delayed 63 kev E 1 transition. (auth)

2312 INVESTIGATION OF DISINTEGRATIONS OF CARBON AND OXYGEN NUCLEI INDUCED BY 15–29 Mev PROTONS. S. S. Vasiliev, V. V. Komarov, and A. M. Popova (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 43: 737-48(Sept. 1962). (In Russian)

The disintegration of C^{12} and O^{16} nuclei into α particles induced by protons with energies between 15 and 29 Mev is investigated by the photographic emulsion technique. The energy distributions of the decay products produced in the reactions $C^{12}(p,p'3\alpha)$ and $O^{16}(p,p'4\alpha)$ are obtained as well as the excitation energies of the intermediate nuclei C^{12}, B^9, and Be^8 possibly produced in the $C^{12}(p,p'3\alpha)$ reactions. An analysis of the experimental data indicates that the main mechanism of the investigated reactions is disintegration of the N^{13} system (in the case of the $C^{12}(p,p'3\alpha)$ reaction) and of the F^{17} system (in the case of the $O^{16}(p,p'4\alpha)$ reaction) into α particles and a proton with their paired resonance interaction in the energy states of the Be^8 and Li^5 nuclei. (auth)

2313 ELASTIC AND INELASTIC SCATTERING OF PROTONS BY Ne^{22} NUCLEI. P. V. Sorokin, A. I. Popov, V. E. Storizhko, and A. Ya. Taranov (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 43: 749-51(Sept. 1962). (In Russian)

Information on the excited levels of the Na^{23} nucleus is obtained by studying the energy dependence of γ-quantum yield and of the angular distribution of protons scattered in the reaction $Ne^{22}(p,p\gamma)$. (auth)

2314 ELASTIC SCATTERING OF 5.45 Mev PROTONS BY Mg ISOTOPES. A. P. Klucharev and N. Ya. Rutkevich (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 43: 775-6(Sept. 1962). (In Russian)

Elastic scattering of 5.45-Mev protons on Mg isotopes was studied. In contrast to heavier isotopes, an anomaly in the angular distribution is observed for the Mg^{24} nucleus. (auth)

2315 INVESTIGATION OF THE STRIPPING REACTION ON NICKEL ISOTOPES. M. V. Pasechnik and P. G. Ivanitskii (Inst. of Physics, Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 43: 777-82(Sept. 1962). (In Russian)

The angular distributions of protons from the (d,p) reaction on nickel isotopes (Ni^{58}, Ni^{60}, Ni^{62}, Ni^{64}) are obtained for deuteron energies of 13.6 Mev. Values of l_n for the captured neutrons and also conclusions regarding the possible values of the spins and parities of the investigated states are obtained by comparing the experimental angular distributions with Butler's theory. (auth)

2316 INVESTIGATION OF α-DECAY OF Am^{241}. S. A. Baranov, V. M. Kulakov, V. G. Zelenkov, and V. M. Shatinskii. Zh. Eksperim. i Teor. Fiz., 43: 795-9(Sept. 1962). (In Russian)

Alpha decay of Am^{241} is studied with a double-focusing magnetic α spectrograph. Analysis of the α spectra revealed the existence of more than 18 fine structure α-ray groups, most of which have been observed for the first time. An energy level scheme for the Np^{237} nucleus is constructed on the basis of the experimental data. The existence of a new rotational band in the indicated scheme is established. (auth)

2317 RESONANCE SCATTERING OF γ-QUANTA ON Sn^{116} NUCLEI. D. K. Kaipov, Yu. K. Shubnyi, R. B. Begzhanov, and A. A. Islamov (Inst. of Nuclear Physics, Academy of Sciences, Kazakh SSR). Zh. Eksperim. i Teor. Fiz., 43: 808-12(Sept. 1962). (In Russian)

Resonance scattering of 1290-kev γ quanta on Sn^{116} nuclei is investigated by using a gaseous In^{116m} source in $InCl_3$. The lifetime of the first excited state determined by the self-absorption method is $\tau_\gamma = (6.4 \pm 2.7) \times 10^{-13}$ sec. (auth)

2318 LOW ENERGY PHOTODEUTERONS FROM LITHIUM. A. S. Belousov, S. V. Rusakov, and E. I. Tamm (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 43: 813-14(Sept. 1962). (In Russian)

The energy dependence of the relative yield of photodeuterons from lithium is examined for energies $E_{\gamma max}$ lying between 160 and 260 Mev. (auth)

2319 ASYMMETRY OF THE β-RADIATION FROM SOME NUCLEI POLARIZED IN AN ALLOY CONTAINING IRON. A. V. Kogan, V. D. Kulkov, L. P. Nikitin, N. M. Reinov, M. F. Stelmakh, and M. Shott (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 43: 828-30(Sept. 1962). (In Russian)

The asymmetry of the β radiation from Re^{186}, Ir^{192}, and In^{114} nuclei polarized in an alloy containing iron at a temperature 0.1 to 0.03°K is measured. The values of the product $\mu_{nuc}H_{eff}$ for the Re^{186} and Ir^{192} nuclei are computed from the formula for allowed β transitions. A comparison of these values of $\mu_{nuc}H_{eff}$ with those obtained by studying the γ-radiation anisotropy shows that for these nuclei the indicated approximation does not yield correct results. The sign of the field H_{eff} in the Re and Ir nuclei in the iron alloy is negative. The relaxation time of the In nuclear spin in the alloy is much less than 70 sec. at the working temperature. The In^{114} nuclear magnetic moment is found to be 1.7 ± 0.4 nuclear magnetons. (auth)

2320 CASCADE α-PARTICLES FROM CARBON NUCLEI SPLIT BY 660 Mev PROTONS. A. P. Zhdanov and P. I. Fedotov (Radium Inst., Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 43: 835-8(Sept. 1962). (In Russian)

The experimental spectra of α particles from carbon nuclei disintegrated by 660-Mev protons are compared with the corresponding spectra computed for an intranuclear cascade in carbon. Collisons of cascade nucleons with substructures of the α-particle type are taken into account in the calculations. Comparison of the calculated spectra with the experimental ones shows that about 70% of cascade α particles of the experimental spectrum can be regarded as the result of direct interaction between the cascade nucleons and intranuclear α substructures. (auth)

2321 PROBABILITY OF TRIPLE FISSION OF U^{233} NUCLEI INDUCED BY RESONANCE NEUTRONS. A. A. Panov (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor Fiz., 43: 847-51(Sept. 1962). (In Russian)

The relative cross section for triple fission of U^{233} nuclei is measured in the 1 to 10 ev neutron energy region by a time-of-flight method with a resolving time of 2 μsec/m. The resonances observed have the same energy as the resonances in double U^{233} fission. Within the limits of statistical errors (<8%) the ratio of the two fission cross sections or the U^{233} triple fission probability are independent of the neutron energy. (auth)

2322 INVESTIGATION OF THE ANGULAR AND ENERGY DISTRIBUTIONS OF PHOTOPROTONS FROM HEAVY NUCLEI. V. G. Shevchenko and B. A. Yurev (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 43: 860-4(Sept. 1962). (In Russian)

The angular and energy distributions and the yields of photoprotons from W nuclei for $E_{\gamma max}$ = 22.5 Mev and 33.5 Mev and from Pt and Pb nuclei for $E_{\gamma max}$ = 22.5 Mev and 33.5 Mev respectively, are measured. The photoproton angular distributions are asymmetric relative to 90°, the maximum being shifted toward small angles. The asymmetry increases with increase of the photoproton energy as well as with increase of the maximal γ-radiation energy. The maximum of the cross sections for photoproton production lies above 22 Mev, and γ-ray absorption in this region is chiefly of a quadrupole nature. (auth)

2323 TRANSFER REACTION OF 2n AND 3n BY BOMBARDMENT OF Al, Cu AND Ta WITH IONS OF N^{15} AND N^{14}. V. V. Volkov, L. Pomorski, J. Tys, and G. N. Flerov. Zh. Eksperim. i Teor. Fiz., 43: 865-72(Sept. 1962). (In Russian)

The transfer reactions of two and three neutrons were investigated by bombardment of Al, Cu, and Ta with ions of N^{15} and N^{14}. Nucleus of N^{17} as detector particle was used. The thick target yields and cross sections in the energy interval 50 to 140 Mev were obtained. Cross sections for the transfer reactions of one, two, and three neutrons are compared. (auth)

2324 OPTICAL POTENTIAL OF HEAVY NUCLEI. M. Ya. Amusyan (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 43: 942-52(Sept. 1962). (In Russian)

An expression for the imaginary part of the optical potential W of heavy atomic nuclei is obtained for different energies of the incident particle ($E > 0$) on the basis of the two-parameter model of nuclear matter. It is shown that at intermediate energies ($E \cong 5$ to 10 Mev) W is large on the surface of the nucleus, and at very high energies ($E >$ 100 Mev) it is simply proportional to the density of the system. For quasi single-particle and hole excitations ($E < 0$) damping occurs on the surface of the system. The formulas obtained are applicable not only to the proton–neutron system (nuclear matter). (auth)

2325 ON TWO TYPES OF NUCLEAR FISSION. Yu. A. Selitskii and V. P. Eismont. Zh. Eksperim. i Teor. Fiz., 43: 1005-8(Sept. 1962). (In Russian)

The data on fragment kinetic energies are considered from the viewpoint of the hypothesis of existence of two independent types of fission, a symmetric and asymmetric type. Many experimental facts can be explained in this way, and the properties of the indicated fission types can be established. (auth)

2326 A MICROSCOPIC DESCRIPTION OF COLLECTIVE LEVELS OF NONSPHERICAL NUCLEI. D. F. Zaretskii and M. G. Urin (Moscow Inst. of Physics Engineering). Zh. Eksperim. i Teor. Fiz., 43: 1021-30(Sept. 1962). (In Russian)

The method of approximate second quantization is employed for investigating the microscopic structure of collective excitations in nonspherical nuclei. The problem of excluding nonphysical states is considered. Corrections to the equation defining the energy and also to the electromagnetic transition probabilities in the case of β-excitations are determined. The calculations are carried out by taking into account the interaction between neutrons and protons. (auth)

2327 VERTEX PARTS OF THE AMPLITUDES FOR DIRECT NUCLEAR PROCESSES. I. S. Shapiro (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 43: 1068-82 (Sept. 1962). (In Russian)

The vertex parts previously introduced are studied on basis of the optical model. The analytical properties of the vertex part as a function of the transferred momentum are investigated. It is shown that even in the case of a potential well with a diffuse edge an essential singular point at infinity corresponds to the nuclear radius. The effect of diffuseness of the nuclear edge on the angular distributions in direct reactions is clarified. The problem of estimating the reduced vertex parts by taking into account dissipation of single particle states is considered. (auth)

2328 ANGEREGTE ZUSTANDE DER DEFORMIERTEN KERNE Re^{187} UND Dy^{160}. (Excited Levels of the Deformed Nuclei Re^{187} and Dy^{160}). Walfried Michaelis. Thesis, Karlsruhe, Ger., Technische Hochschule, 1962. 148p.

The level schemes of the deformed nuclei Re^{187} and Dy^{160} are studied. The γ spectra following β decay of W^{187} and Tb^{160} were measured using Compton and pair spectrometers and sum-coincidence and γ-γ coincidence methods. The angular distribution and polarization of γ cascades were determined with an automatic angular correlation polarimeter. The level scheme of Re^{187} shows 38 lines, 7 of which have not been observed previously. Most of the data on Re^{187} can be explained by the Nilsson model but there are also indications of disagreement. The level scheme for Dy^{160} shows 19 lines. For the levels at 87, 964, 1047, and 1262 kev spins and parities of 2^+, 2^+, 3^+, and 2^-, respectively, were determined. These results are in agreement with theoretical predictions. (Gmelin)

2329 DIE SPINS DES 9.16-Mev UND DES 6.44-Mev ZUSTANDES IN N^{14}. (The Spins of the 9.16-Mev and 6.44-Mev Levels in N^{14}). Hans Juergen Rose. Thesis, Freiburg i. Br., Albert-Ludwigs-Universität, 1959. 21p.

Using the reaction $C^{13}(p,\gamma)N^{14}$ with protons having the energy of the 1.75 Mev resonance, the gamma cascade from the 9.16 Mev level to 6.44 Mev level and from there to the ground level of N^{14} is studied. Measurements of angular correlations and distributions for various geometries in relation to the proton beam established the spins of the 9.16 Mev and 6.44 Mev levels to be 2 and 3 respectively. (Gmelin)

2330 TEMPERATURE DEPENDENCE OF QUADRUPOLE INTERACTION ON 0.48 Mev LEVEL OF Ta^{181} IN HAFNIUM SINGLE CRYSTALS. Pullomparampil John Ouseph. Thesis, New York, Fordham Univ., 1962. 69p.

When two gamma rays are emitted by a nucleus, the probability $W(\Theta)$ that the directions of the two gamma rays subtend an angle Θ between each other is known as the angular correlation. This function depends on the angular momenta of the gamma rays and the spins of the initial, intermediate, and the final nuclear states. The angular correlation will be altered if the intermediate state is perturbed by an electric or magnetic field. The amount of perturbation depends on the intensity of the field, the magnetic dipole moment, or the electric quadrupole moment of the intermediate state, direction of the field and the life time of the level. Ta^{181} is a suitable nucleus for crystalline field studies. The unperturbed anisotropy between the gamma rays 0.132 and 0.48 Mev is high (–0.43) and the half life of the intermediate state is long (1.5×10^{-9} sec). Ta^{181} is produced by β^- decay of Hf^{181}. The latter can be produced in natural hafnium by neutron irradiation, which involves the reaction Hf^{180} (n,γ) Hf^{181}. Hafnium is hexagonal and has

an electric field gradient along its c-axis. This field will interact with the quadrupole moment of the 0.48 Mev level and the perturbation of angular correlation can be used to estimate the interaction strength. Since hafnium metal remains hexagonal to a very high temperature, single crystal sources are suitable for study of the temperature dependence of quadrupole interaction. Crystals obtained from two sources were used for the experiment. One set of crystals was obtained from AEC and the other set was prepared by zone refinement. Both type crystals were analyzed by x-ray back reflection methods for determination of the c-axis. The crystals were cut in cylindrical form with their c-axis perpendicular to the cylindrical axis. These crystals were irradiated in the Brookhaven Reactor and the experiments were completed in two half lives (92 days) of Hf^{181}. To register the coincidences between the pulses from the two counters, a double-fast-triple-slow coincidence circuit with pulse height analyzers in both channels was constructed. The resolution time of the circuit was 7.5×10^{-8} sec. Keeping the c-axis along the direction of the first gamma ray, the angular correlation function was determined for crystals of different diameters. From these measurements, it was found that the experimental results for the 0.1 cm diameter crystal agreed with the theoretical curve. The theoretical calculations were made assuming a mixing ratio $\delta = 6.4 \pm 0.8$ according to the measurements of Grabowsky et al. The crystals were mounted on the holder and the anisotropy measured for different angles φ (φ = angle between the c-axis and the direction of the fixed counter) and for different temperatures. The AEC crystals showed changes in the anisotropy vs angle curve for varying temperatures. The type changes observed could be explained as due to the rotation of small crystallites in the crystal. This type of rotation is observed in the annealing of imperfect crystals. The zone-refined crystals did not show any temperature change in the anisotropy-φ curve. The results of the room temperature measurements gave an interaction frequency 56.58 ± 5.09 HC/sec. The experiments showed that the perturbation in non-magnetic metallic crystals is due to the static electric field. The measurements at 200, 400, and 500°C detected no change in quadrupole interaction strength. (Dissertation Abstr., 23: No. 3, 1962)

2331 SELF-CONSISTENT-FIELD NUCLEAR WAVE FUNCTIONS FOR O^{16}, O^{15} AND EXPLANATION OF SPIN-ORBIT COUPLING THROUGH TENSOR FORCE. Nazakat Ullah. Thesis, Boston, Boston Univ. Graduate School, 1962. 124p.

A matrix version of Hartree-Fock self-consistent-field calculation is applied to O^{16} and O^{15} nuclei. The two-body interaction operator employed has a Serber exchange character with repulsive core and tensor component. A projection operator technique was used to construct $^{1,1}S$ wave functions from the various excited configurations which interact with the ground state. The configuration interaction calculation gives the ground state energy of O^{16} to be −129.91 Mev, neglecting the Coulomb forces, which contribute 18.24 Mev. An attempt is made to perturb the shell model ground state wave function by mixing d orbital with occupied p orbital and f orbital with occupied s orbital, but it turned out that no such mixing occurs. The $p_{\frac{3}{2}} - p_{\frac{1}{2}}$ splitting in O^{15} nucleus due to the tensor force is estimated to be 4.05 Mev, but the calculation puts the $p_{\frac{3}{2}}$ level lower than the $p_{\frac{1}{2}}$ level. (Dissertation Abstr., 23: No. 3, 1962)

2332 EXPERIMENTAL STUDIES OF OSMIUM-188. Laurance Bliss Warner. Thesis, Tallahassee, Florida State Univ., 1962. 108p.

An experimental investigation of the nuclear energy levels of Os^{188} was conducted in order to provide a link between the deformed nuclei, with mass number roughly between 152 and 190, and the spherical nuclei, with mass number around 208, in the hope of illuminating the mechanism of intermediate coupling, allowing comparison of certain nuclear models and understanding anomalies between models and other trends in this region of the nuclear periodic table. The studies were performed in two parts: first, through the analysis of the decay products of Re^{188} and Ir^{188}, and, second, through the analysis of the reaction $Os^{187}(d,p)Os^{188}$. Forty-one-hour Ir^{188} was produced by $Re^{187}(\alpha,3n)Ir^{188}$ and studied in the Gerholm electron-electron coincidence spectrometer and a conventional gamma-gamma spectrometer, both with fast-slow coincidence electronics. Seventeen-hour Re^{188} and 21-minute Re^{188m} were produced by $Re^{187}(n,\gamma)Re^{188}$ and examined with fast-slow gamma-gamma coincidence equipment. The weak positron spectrum of Ir^{188} was analyzed and found to consist of branches with end points at 1656 ± 10 kev and 1211 ± 45 kev, yielding $Q_{\beta^+} = 1811 \pm 10$ kev. Coincidence relations and conversion electron energies, while confirming the main features of previously proposed decay schemes, suggest several additional states. The reaction $Os^{187}(d,p)Os^{188}$ was investigated, using 12-Mev deuterons and analyzing the outgoing protons with a broad-range magnetic spectrograph. The Q value of the reaction was set at 5602 ± 20 kev. Low-lying levels are in agreement with those observed in the decay spectroscopy; new states were observed above the energy accessible in the decay experiment. The energy level scheme obtained in these experiments was compared with the predictions of the models of Bohr and Mottelson and of Davydov and Chaban; these comparisons confirm the previous classification of Os^{188} as a transitional or intermediate-coupling nucleus, in agreement with its location in the nuclear periodic table between strongly deformed and spherical nuclei. (Dissertation Abstr., 23: No. 3, 1962)

2333 THE DECAY OF Eu^{149}. Otto K. Harling. Thesis, University Park, Pennsylvania State Univ., 1962. 57p.

The electron capture decay of Eu^{149} to Sm^{149} was studied using scintillation and proportional counters. A decay scheme is given which is consistent with the measured coincidence data. The half life of the Eu^{149} decay was measured to be 106 ± 2 days. Some coincidence data for the Eu^{148} decay are also presented. (Dissertation Abstr., 23: No. 3, 1962)

2334 ADDITIONAL CONSERVATION LAWS IN THE STATISTICAL MODEL FOR MESON PRODUCTION. Jonas Schultz. Thesis, New York, Columbia Univ., 1962. 62p.

An analogue of the one-parameter Fermi statistical model for meson production is formulated, in which energy, linear momentum, angular momentum, and parity are rigorously conserved. Results can be obtained from the model for the case where the energy release and the number of particles produced are small. A specific application is made to the production of $K + \bar{K}$ with a limited number of pions in proton-antiproton annihilations at rest. Charge conjugation and isotopic spin invariance are also considered. The generalization to a two-parameter model and the resulting modifications of the results are discussed. Finally, estimates are made of the relative probabilities of different decay modes of the neutral kaons produced in the annihilation process. (Dissertation Abstr., 23: No. 3, 1962)

2335 NEW METHODS IN REARRANGEMENT COLLISIONS. Ronald Aaron. Thesis, Philadelphia, Univ. of Pennsylvania, 1961. 141p.

Mathematical methods developed for use in elementary particle physics are applied to the problem of rearrangement collisions, in nuclear reactions in particular, to the deuteron stripping process which is a typical example of a rearrangement collision. Using the contraction rules of Lehmann, Symanzik, and Zimmermann in the Heisenberg representation, several expansions are derived for the stripping T-matrix. Some of these are equivalent to the usual Lippmann-Schwinger expansion, but others are unique, and lend themselves naturally to the application of modern dispersion theory. It is these expansions that are treated in detail. Because the analytic techniques used are new and unfamiliar in the present context, the thesis is limited to a discussion of direct nuclear reactions (which class, of course, includes stripping reactions) and processes in which compound nucleus formation or collective effects occur are not discussed. However, in principle, the methods are applicable to all reactions. In the first few sections of the thesis some of the formal and calculational difficulties associated with the traditional approach to the problem of rearrangement collisions are discussed—one very important difficulty being the lack of a formally correct perturbation scheme. It is proven that because all the potentials in the problem are capable of supporting bound states, the usual Born series which is an expansion in one or more of the potentials diverges independent of the incident energy (in marked contrast to what occurs in potential scattering). Field theoretic methods are then applied in an attempt to remedy some of the above problems. In order to use the new expansions for the T-matrix discussed previously, it is found necessary to replace some to the bound states in the problem by elementary particles—that is, in the second quantized formalism which is used, an independent field operator which commutes with all the other operators in the theory must be introduced into the Lagrangian to describe a bound state. In fact, the method of performing this replacement forms one of the central points of the thesis, and leads later to a discussion of a possible distinction between elementary particles and bound states in general. It is then shown how dispersion techniques may be used to evaluate some of the matrix elements in the problem. It is finally shown that the new methods used solve many of the formal difficulties associated with the traditional approach to the problem. Also the solutions obtained seem more amenable to approximate solution. The formalism is constructed so as to divide collision into whole physical sub-units rather than, as in the Born series, into a power series in a necessarily strong interaction, and it seems possible to pick out those contributions which are of greatest importance. Also, it is possible to relate the cross sections for reactions to elastic scattering data so that no reaction radius or similar fitting parameter need enter the theory. (Dissertation Abstr., 23: No. 3, 1962)

Particle Accelerators

2336 (CERN/EAG/3) EUROPEAN ACCELERATOR STUDY GROUP THIRD MEETING, AMSTERDAM, MAY 14-15, 1962. NOTES. (European Organization for Nuclear Research, Geneva). July 5, 1962. 93p.

Discussions were presented on future requirements of high-energy physics, activities at the Los Angeles Conference, the meson-factory project in Zürich, the Yale 600-Mev proton linear accelerator, ejection problems in cyclotrons and synchrocyclotrons, injection into high-energy synchrotrons, a 60 Bev cascade machine, air core magnets for FFAG accelerators, comparison of linear and circular electron accelerators, storage ring devices, synchrotron radiation damping, injection into storage rings, and field patterns for storage rings. (J.R.D.)

2337 (JINR-P-1013) KACHESTVENNOE OPISANIE REZONANSNYKH YAVLENII V NELINEINOI SISTEME. 1. (Qualitative Description of Resonance Phenomena in the Non-Linear System. [Part] I). V. K. Mel'nikov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 17p.

A qualitative description of strong resonances and the conditions for its appearance in the non-linear system are given. A new method is suggested for calculating resonances in the nonlinear system, e.g. for cyclic accelerators with the space variation of the magnetic field strength. Using this method, the stability of radial oscillations in an isochronous cyclotron is treated. (auth)

2338 (MURA-644) THE EXCITATION OF A CIRCULAR CYLINDRICAL CAVITY BY A CIRCULAR WAVEGUIDE. C. Bjerke and J. Van Bladel (Midwestern Universities Research Assn., Madison). July 20, 1962. Contract AT(11-1)-384. 20p.

The problem of determining the pressure in a circular cylindrical cavity of radius b connected to a circular input waveguide of radius a is formulated in terms of an integral equation. Values of the reflection coefficient in the guide and of the pressure in the cavity are given in terms of the frequency and of the dimensionless ratio a/b. The problem of the cavity with an input and an output waveguide is also analyzed, and values of the transmission coefficient are obtained. (auth)

2339 (TID-16867) HIGH MAGNETIC FIELDS. T. H. Fields (Argonne National Lab., Ill. and Northwestern Univ., Evanston, Ill.). July 1962. Contract [W-31-109-eng-38]. 21p. (UAC-6664)

Developments in the area of superconducting magnets are discussed. A brief review of pulsed and cryogenic magnet development is included. (J.R.D.)

2340 (TID-17059) ON THE RELATIVISTIC SPIN EQUATION AND THE DEPOLARIZATION IN A SYNCHROTRON. Tat K. Khoe and Lee C. Teng (Argonne National Lab., Ill.). Mar. 6, 1962. Contract [W-31-109-eng-38]. 27p. (ANLAD-69)

The forms of relativistic spin equations given by various authors are examined, their derivations and notations are unified, and the correlations between these diverse forms are interpreted and exhibited. The depolarizing resonances between the oscillating magnetic field and the spin precession experienced by a polarized beam of particles being accelerated in a synchrotron are also studied. The calculation is made in the rest-frame of the particle. In addition to the main vertical guide magnetic field effects, the particles experience a small oscillating horizontal magnetic field caused by the betatron oscillations. Standard technique used in treating magnetic resonance problems can then be applied with the small oscillating horizontal field considered as the applied r-f for inducing resonant transitions. Methods of suppressing the effects of these resonances are discussed. (auth)

2341 (TID-17186) LINEAR ACCELERATOR PROJECT PROGRESS REPORT FOR JULY 1962–SEPTEMBER 1962. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-3)-328. 44p.

Results are reported for asymptotic neutron spectrum measurements. Most of the measurements were made on a spectrum source region consisting of polyethylene. Dieway experiments are described. Preliminary measurements

were made on water. Neutron capture cross section experiments are described. Results are given for iron. The polarization of photoneutrons emitted in the photodisintegration of deuterium was measured. (M.C.G.)

2342 30-Mev LINEAR ELECTRON ACCELERATOR FOR NEUTRON SPECTROSCOPY. R. M. Voronkov, M. I. Pevzner, N. N. Flerov, A. V. Aref'ev, M. I. Basalaev, V. M. Korolev, S. S. Moskalev, and V. P. Osipov. At. Energ. (USSR), 13: 327-36(Oct. 1962). (In Russian)

Details of the new linear electron accelerator of the I. V. Kurchatov Institute are described. The energy of the machine, designed at the Radiotechnical Institute, ranges from 25 to 32 Mev; it has a pulse current of 200 ma and pulse durations of 0.6, 0.2, and 0.05 msec with a frequencies up to 100 hertz. The energy of the high-frequency field is transformed into electron energy with a frequency of 30 to 35%. A klystron is used as the high-frequency source; the vacuum is maintained by means of Ti getters. The current pulses injected are generated by a 3-electrode gun. The accelerated electron beam falls on a U target, the bremsstrahlung of which generated fast neutrons by (γ,n) and (γ,f) reactions; the neutrons emitted by the target have a Maxwellian distribution. The U^{238} target is placed in a cylindrical container filled with water serving as moderator. The experiments carried out include measurement of the current and the spectrum of the accelerated electrons and the determination of the radial distribution of the current density within the beam. The energy spectrum measurements were carried out by the time-of-flight method at a distance of 109 m in the energy range from 4 ev to 30 kev. The energy dependence of the background was found to amount to 5% of the total effect at energies up to 200 ev, increasing to 15% at 6 kev. (TTT)

2343 CALCULATION AND DESIGN OF ACCELERATOR SIGNAL ELECTRODES. I. P. Karabekov and M. A. Martirosyan. At. Energ. (USSR), 13: 337-41(Oct. 1962). (In Russian)

Strong-focusing accelerators operated at energy levels of several Bev require detailed information concerning the particle orbits in order to allow optimization of the parameters; unfortunately, the space available for the needed electrodes is often too small to yield satisfactory results. This must therefore be carefully considered in the design. A method was developed for carrying out such calculations on the basis of the parameters of the bunched electrons and the available dimensions of the clearance of the accelerator's vacuum chamber. The calculations allowed the sensitivity of the electrodes to be determined as a function of the intensity and the location of the beam. Direct experimentation confirmed the results of the calculation. (TTT)

2344 ELECTROSTATIC ACCELERATORS. R. Gerbier (Centre d'Études Nucléaires, Grenoble, France). Bull. Inform. Sci. Tech. (Paris), No. 60, 6-15(Apr. 1962). (In French)

The various methods presently in use for producing the continuous high voltage necessary for the operation of electrostatic accelerators are reviewed. The methods considered are voltage multiplier units (Greinacher and Morganstern types) and electrostatic instruments (Van de Graaff and Trump machines and Felici rotating cylinder instruments). The electrostatic accelerators used at Grenoble which give currents of several milliamperes at voltages up to 1.2 Mv are described. In this energy region electron accelerators and neutron generators offer very interesting possibilities. (auth)

2345 THE VAN DE GRAAFF TANDEM. B. Olkowsky. Bull. Inform. Sci. Tech. (Paris), No. 60, 16-22(Apr. 1962). (In French)

The operation of a Van de Graaff tandem is described, and some consideration is given to the duoplasmatron source. The possible combination of tandem instruments, suggested by Van de Graaff, are outlined. Prospects for the development of this type of instrument are given. (auth)

2346 LINEAR ACCELERATORS: DESIGN, CONSTRUCTION, PROJECTS. R. Jean. Bull. Inform. Sci. Tech. (Paris), No. 60, 29-38(Apr. 1962). (In French)

The stationary wave structure necessary to accelerate low-energy ions has restricted the development of linear accelerators for this purpose, but at high energies this disadvantage is no longer present. A simplified discussion of the problems involved in building such machines leads to the conclusion that constant field structure on 10-cm wave lengths is the most economical because of the number of elements, building dimensions, and power consumption. The practical construction problems are discussed. Possible application of linear accelerators for ion acceleration are reviewed. (auth)

2347 IMPROVEMENTS TO THE SACLAY ELECTRON LINEAR ACCELERATOR. R. Bergère and A. Veyssière. Bull. Inform. Sci. Tech. (Paris), No. 60, 39-59(Apr. 1962). (In French)

The improvements which will be made to the Saclay linear accelerator are described. They include the addition of a third section, positron acceleration, development of chemical activation and analysis, introduction of a triode gun for short pulses at high current, increase of frequency stability of h-f pilot, reduction in use of mm waves, and use of the fine structure at 10^{-11} sec of the beam of the accelerated electron. (auth)

2348 RESEARCH WITH PHOTONS AND ELECTRONS AT THE 28-Mev LINEAR ACCELERATOR. C. Tzara. Bull. Inform. Sci. Tech. (Paris), No. 60, 74-7(Apr. 1962). (In French)

The principal work at Saclay has been obtaining good energy definition in photon-induced reactions. The methods used are described; either a photon beam of variable energy and narrow spectrum is produced or a fine energy band is isolated from a continuous spectrum. The results obtained are reviewed. (auth)

2349 THE ORSAY LINEAR ACCELERATOR. L. Burnod and J. L. Delcroix. Bull. Inform. Sci. Tech. (Paris), No. 60, 78-83(Apr. 1962). (In French)

The 1.3-Bev linear accelerator at Orsay is briefly described. The current obtained is appreciably higher than foreseen in the original specification. The main improvements under study are indicated, and the principal physics experiments planned or under study are tabulated. (auth)

2350 THE SECTOR-FOCUS CYCLOTRON, ITS USE AT SACLAY. J. Thirion. Bull. Inform. Sci. Tech. (Paris), No. 60, 90-8(Apr. 1962). (In French)

The advantages of a sector-focus cyclotron are presented, and the specifications of the Phillips cyclotron are given. The installation at Saclay will include beam distribution in the experimental area. The general layout of the magnets is described. (auth)

2351 HIGH ENERGY ALTERNATING GRADIENT SYNCHROTRONS. G. Bronca and G. Neyret. Bull. Inform. Sci. Tech. (Paris), No. 60, 99-106(Apr. 1962). (In French)

A preliminary plan for a 60-Bev alternating-gradient synchrotron to be constructed at Saclay is outlined. This

machine will use a series injector consisting of a 50-Mev linear accelerator followed by a 1.5-Bev alternating-gradient synchrotron with rapid cycling. A detailed calculation of the main parameters is followed by a tabulation of these parameters of these two synchrotrons. (auth)

2352 STUDY OF MULTICHARGED ION SOURCE FOR A CYCLOTRON. Robert Basile and Jean-Marie Lagrange (Laboratoire Joliot-Curie, Orsay, France). J. Phys. Radium, 23: Suppl. to No. 6, 111A-16A(June 1962). (In French)

After describing the equipment for the study of a heavy multi-charged ion source intended for the variable energy synchronous cyclotron which is being constructed at Orsay, and defining several points in the experimental technique, the results obtained using a d-c arc discharge with air or pure nitrogen as gas are given. After a magnetic analysis, taking into consideration conditions which will further be defined, the following spectrum (the percentage being that of the total nitrogen ion current) was obtained: 33% for N^{+}, 33.5% for N^{2+}, 30% for N^{3+}, 3.5% for N^{4+}, and 0.15% for N^{5+}. (auth)

2353 ANOMALIES DETECTED IN THE CYCLOTRON RESONANCE OF AN ELECTRON BEAM. M. Peach and Z. Zarudiansky (École Supérieure de Physique et de Chimie, Paris). J. Phys. Radium, 23: Suppl. to No. 6, 135A-6A (June 1962). (In French)

During the course of a study on the determination of the ratio of the frequency of proton precession and the cyclotron frequency of electrons by the Gardner-Purcell method, some anomalies in the cyclotron resonances were observed, and an explanation of these anomalies is given. When a high-frequency electromagnetic field is produced at the interior of a wave guide, in a direction perpendicular to the induction and therefore to the electron beam, the trajectories are modified so that the radius of the helix tends to be increased when the frequency of the electromagnetic field approaches a critical resonance value. This phenomenon is explained if the alternating electric field is considered as the sum of two fields rotating in opposite directions in the plane perpendicular to the induction. Experiments showed that there were two resonant frequencies which can be explained by a consideration of the form of the wave guide field. In the second anomaly the resonance is not always shown by a decrease of the current received, but sometimes by a sharp increase. This is explained by a space charged effect. A sharp increase of current is observed at resonance when a high-frequency field is applied when the guide is blocked. Operating with a weak plate current causes a strong decrease of the current. (J.S.R.)

2354 A VAN DE GRAAFF BEAM DEFLECTING SYSTEM EMPLOYING TWO 45° DEFLECTING MAGNETS. S. E. Hunt and E. C. Fellows (Associated Electrical Industries Ltd., Aldermaston, Berks, Eng.). Nucl. Instr. Methods, 16: 326-34(Aug. 1962). (In English)

Two 45° deflecting magnets were used to form a telescopic system and deflect the beam from a Van de Graaff accelerator through 90°. Energy measurement and stabilization was achieved without loss of primary beam by taking correcting signals from slits placed at the focus of the mass 3 particles. The circuits used to stabilize the magnetic fields are described in detail. The throughput, stability, and focussing properties of the system were tested experimentally and shown to be satisfactory. (auth)

2355 CHARGED PARTICLE STABILITY IN STORAGE RINGS. V. K. Grishin. Vestn. Mosk. Univ., Ser. III, No. 3, 75-81(May-June 1962). (In Russian)

The influence of charged particle longitudinal fields on their motion in $d\omega/dE > 0$ systems was studied by means of kinetic equations. The existence of azimuthally limited particle clusters phased by proper fields were analyzed, and a stable shape for a localized plasma cluster was found. (tr-auth)

2356 ON THE POSSIBILITY OF ACCELERATING CHARGED PARTICLES BY ELECTROMAGNETIC WAVES IN A CONSTANT MAGNETIC FIELD. V. Ya. Davydovski (Novokuznetsk State Pedagogical Inst., USSR). Zh. Eksperim. i Teor. Fiz., 43: 886-8(Sept. 1962). (In Russian)

The integral of motion is found for a charged particle in a constant magnetic field and a field of electromagnetic waves. It allows to deduce that the cyclotron resonance can be maintained for a sufficiently long time, so that the energy of the particle can increase considerably. (auth)

2357 MAGNETIC DEFLECTOR. A. V. Popov, P. V. Smirnov, and I. A. Shukeilo. Zh. Tekhn. Fiz., 32: 1037-9 (Sept. 1962). (In Russian)

A 30-cm electromagnetic accelerator beam deflector with a ferrite core and two plane-parallel bus bars forming a coil synchronized to the circuit was designed. The performance of the device for deflecting relativistic electron beams was equivalent to the performance of an electrostatic deflector with identical parameters, length and electric field intensity (80 kw/cm). (R.V.J.)

2358 INTENSITY OF BETATRON RADIATION AS FUNCTION OF INJECTION VOLTAGE. V. A. Moskalev and B. V. Okulov. Zh. Tekhn. Fiz., 32: 1040-1(Sept. 1962). (In Russian)

The intensity of betatron radiation emission as a function of injection voltage was studied using a 25-Mev betatron with a 350-kw external electron injector. The injection voltage was measured every 20 to 30 kw from 50 to 250 kw. The results showed that up to 250 kw, emission intensity increases according to theory. It is suggested that an increase in injection intensity up to 1000 kw and over should result in a considerable rise in emission intensity. (R.V.J.)

2359 ION ACCELERATORS. Siegfried Klein and Jacques R. Pottier (to Commissariat à l'Energie Atomique). Canadian Patent 647,606. Aug. 28, 1962.

A linear electrostatic accelerator is designed which requires only a low-voltage source and can accelerate different kinds of ions. The accelerator comprises an evacuated tubular chamber fed with ion pulses, a series of electrodes partly permeable to ions, a high d-c voltage source with a first terminal at the reference potential and a second terminal, a series of high-resistance resistors with each one end-connected to one of the electrodes, and means for connecting the second terminal of the source to all the other ends of the resistors. (D.L.C.)

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Refer also to abstract 2066.

2360 (D1-82-0198) HELICAL INSTABILITIES IN SOLID-STATE PLASMAS. Oeivin Holter (Bergen. Universitetet and Boeing Scientific Research Labs., Seattle). Sept. 1962. 61p.

The background of thermal carriers is included in a theory for helical instabilities in electron-hole plasmas. The theory applies to any injection level in intrinsic, n-type, and p-type semiconductors and to insulators. Given the temperature dependence of the mobilities, one can de-

termine the plasma temperature from the electric field at the onset of instability. Then the frequency of the instability can be calculated. A comparison with Ancker-Johnson's experiment in p-InSb shows that the calculated frequencies are within 20% of the experimental values for high magnetic fields, and are a factor ~2 smaller for low fields. The calculated plasma temperature reaches the optical phonon energy at an electric field of approximately 55 V/cm, and remains close to this temperature for higher fields. The results of numerical calculations for a number of different materials are given. (auth)

2361 (DCAS-TDR-62-20) ENERGY CONVERSION PROGRAM. THERMIONIC CONVERTER STUDIES. Semiannual Technical Report, July 1–December 31, 1961. G. L. Johnston (Aerospace Corp., El Segundo, Calif.). Feb. 14, 1962. Contract AF04(647)-930. 19p. (AD-274694; TDR-930(2220-50)TR-2)

Work continued on the fabrication of the plane-parallel Cs thermionic converter and the spectroscopic converter, which are near completion, and on the analysis of a collector sheath of a plasma converter. Studies were initiated and completed on a glass envelope thermionic converter and on theoretical calculations of thermodynamics and transport properties of Cs vapor. Theoretical studies of the interaction of Cs vapor and refractory metal surfaces were initiated. (auth)

2362 (JUL-61-PP) EXPERIMENTE ZUR AUFHEIZUNG EINES DEUTERIUM-PLASMAS MIT HILFE EINER SCHNELLEN MAGNETISCHEN KOMPRESSION. (Experiments on Heating a Deuterium Plasma Using Fast Magnetic Compression). Eduard Hintz (Kernforschungsanlage. Institut für Plasmaphysik, Jülich, Germany). July 1962. 82p.

Experiments on the production of a deuterium plasma of high density and high temperature are described. The goal of the investigation was to develop a method that allows the initial conditions for the magnetic field and plasma purity to be chosen. Heating of the plasma was divided into three phases: pre-ionization of the deuterium gas, pre-heating of the gas, and heating of the plasma by fast compression with the help of a fast-rising magnetic field. In this way, for example, a plasma with a temperature of about one million degrees and a particle density of 10^{17} cm^{-3} could be produced. (M.C.G.)

2363 (NP-12191) RESEARCH ON THE VORTEX MHD POWER GENERATOR. Quarterly Progress Report No. 2. W. C. Davis and R. T. Craig (TAPCO. Div. of Thompson Ramo Wooldridge Inc., Cleveland). Oct. 1962. Contract NAS3-2526. 21p. (ER-5084)

Fabrication of the experimental model of the vortex magnetohydrodynamic generator was completed and appears to be satisfactory in its conceptual design. A gas dilution calorimeter was constructed for determining the enthalpy of the driving jets under conditions simulating those within the generator. The calorimeter will also be used for determining local heat transfer coefficients within the vortex generator and generator conversion efficiency. The vortex chamber installation was completed and soon will be providing more comprehensive and accurate data for the determination of velocity fields within vortex cavities supplied with and without center bodies. Further study of the application of pseudo-laminar boundary layer analysis to the prediction of velocity profiles within a turbulent vortex confirmed the earlier expectations of its successful employment. (auth)

2364 (NYO-10424) SUMMARIES OF PAPERS PRESENTED AT THE MEETING ON THEORETICAL ASPECTS OF CONTROLLED THERMONUCLEAR FUSION, HELD AT NEW YORK UNIVERSITY, APRIL 30–MAY 1, 1962. (New York Univ., New York. Courant Inst. of Mathematical Sciences). July 31, 1962. Contract AT (30-1)-1480. 33p. (MF-32)

The papers are concerned with containment in mirror machines, confinement and theory of one-dimensional plasmas, kinetics of Lorentz plasmas, theory of the Astron E-layer, confinement of deuterium plasmas, cusped-magnetic-field plasma confinement, new results in plasma confinement, kinetics of nonadiabatic plasma confinement, plasma instabilities, secondary plasma growth, plasma quantum mechanics, theory of electron-photon gases, and plasma ion-group thermalization. (J.R.D.)

2365 (TID-17074) INTERPLANETARY PLASMA. Bruno Rossi (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). [Oct. 29, 1962]. Contract AT (30-1)-2098. 16p.

Experimental evidence concerning the existence and the properties of ionized gases in interplanetary space is reviewed. Terrestrial observations of the scattering of visible sunlight, acceleration and ionization of gases forming comet tails, occultation of radio stars, and correlations between solar activity and geophysical effects are described. Measurements carried out by means of space vehicles are discussed. The future of plasma studies in interplanetary space is outlined. (M.C.G.)

2366 (FTD-TT-62-890) INVESTIGATION OF TECHNICAL UTILIZATION OF PLASMA. Tibor Kugler and Konstantin Miklossy. Translated from Elektrotech. Obzor, 49: No. 3, 153-8(1960). 20p.

The possibilities of technical utilization of plasma are discussed. Arc lights and arc welding are described. The conditions for long-lasting preservation of the arc and the problem of its extinction are discussed. The processes in an arc artificially stabilized by foreign media are considered. Uses of the plasmatron are described. (M.C.G.)

2367 (JPRS-15923) RESULTS OF AN INVESTIGATION OF THE PROPERTIES OF A WATER-STABILIZED ARC. G. Yu. Dautov and M. F. Zhukov. Translated from Zh. Prikl. Mekhan. i Tekhn. Fiz., No. 2, 32-6(1962). 9p.

A method of operating a water-stabilized arc without the use of a ballast resistance in the circuit is described. A plasmatron was investigated in which a water-stabilized arc was used. Results of this investigation indicated that the use of radial magnetic fields to rotate the arc is effective. When the bases of the arc are displaced at high speed, the erosion of the electrode material is reduced and the plasmatron operating time is increased. Cases are noted in which a rising volt-ampere curve is obtained that permits operation of a water-stabilized arc plasmatron with a rotating magnetic field which functions without a ballast resistance. (J.R.D.)

2368 (UCRL-Trans-869(L)) THEORY OF TRANSFER PROCESSES IN A PLASMA ACROSS A MAGNETIC FIELD. V. P. Silin (Akademiya Nauk S.S.S.R. Institut Fiziki im. P. N. Lebedeva). Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Livermore) from Report A-83. 1962. 13p.

A theory is described for the transfer phenomena in a plasma across a constant magnetic field. It is shown that with fairly large ratios of electron and ion temperatures, the effects of particle interaction with plasma oscillations leads to a substantial change of transfer coefficient form. The feasibility of using the excitation theory with respect to the parameter which defines the interaction of plasma particles quantitatively is considered along with the limitations

of small magnetic fields. The applicability of a general condition of resolution according to reciprocal powers of the magnetic field, which corresponds to dimensions of collision frequency in comparison with the Larmor frequency is shown. (J.R.D.)

2369 THE INITIAL VALUE PROBLEM FOR LONGITUDINAL AND TRANSVERSAL PLASMA OSCILLATIONS. Roman S. Żelazny (Case Inst. of Tech., Cleveland). Ann. Phys. (N. Y.), 20: 261-78(Nov. 1962).

The solution of the initial value problem is treated, for the collisionless nonrelativistic linearized Boltzmann-Vlasov equation for longitudinal and transversal plasma oscillations. Ions are treated as a positive charge background. The method of solution is based upon the eigenfunction expansion method. The problem is reduced to the solution of a system of singular integral equations. In the case of the (anisotropic) equilibrium distribution function, the phenomenon of coupling of longitudinal and transversal plasma oscillations is found and discussed. (auth)

2370 ELECTRICAL CHARACTERISTICS OF A HIGH PRESSURE TOROIDAL DISCHARGE. E. A. Witalis (Royal Inst. of Tech., Stockholm). Arkiv Fysik, 22: 375-87(1962). (In English)

External electrical measurements are performed on a small, intense toroidal helium discharge for initial pressures of 1 to 400 torr. The plasma channel resistance, inductance, power input, and supplied thermal energy are found, and these results provide information about the heating of the plasma and its dimensions as functions of the initial pressure and time. At low densities fast pinch properties are recognized and described. An interaction phenomenon between the applied alternating electrical field and the periodic self-compressions of the plasma is investigated. With increasing initial pressure the discharge distinctly changes its character, to become cleaner and more concentrated. Theoretical relations giving the plasma internal energy, density, temperature, and heating time are discussed and applied. The results are compared with those from the experiment in order to obtain information about the energy losses. (auth)

2371 USE OF BALLISTIC PENDULUMS WITH PULSED PLASMA ACCELERATORS. T. J. Gooding, B. R. Hayworth, And R. H. Lovberg (General Dynamics/Astronautics, San Diego, Calif.). ARS (Am. Rocket Soc.) J., 32: 1599-1600(Oct. 1962).

Experiments were conducted with a pulsed coaxial plasma gun which showed that thrust measurements with a ballistic pendulum involves large errors. The deflection was found to depend on the magnetic pressure of the plasma and on the vaporizability of the pendulum material. (D.L.C.)

2372 FLOW OF A HIGHLY CONDUCTING PLASMA IN A CONVERGING-DIVERGING NOZZLE. H. A. Hassan (Virginia Polytechnic Inst., Blacksburg, Va.). ARS (Am. Rocket Soc.) J., 32: 1610-12(Oct. 1962).

A closed form solution of the flow of a plasma of infinite electrical conductivity in a converging-diverging nozzle under the action of a crossed magnetic and electric fields is presented. The flow properties and the area ratio are expressed in terms of the temperature ratio and two parameters. The first parameter is the ratio of specific heats, and the second, λ, is proportional to the ratio of the magnetic pressure to the static pressure in the settling chamber. It is found that the maximum mass flow and the specific impulse vary linearly with λ for large λ. (auth)

2373 PLASMA-ELECTRODE PHENOMENA OF THE RAIL TYPE OF ACCELERATOR. D. L. Clingman and T. L. Rosebrock (General Motors Corp., Indianapolis). ARS (Am. Rocket Soc.) J., 32: 1613-14(Oct. 1962).

Experiments were conducted on a rail type of electromagnetic accelerator which uses an exploded metal wire to form the plasma. The discharge is not filamentary, and both Amperian and retrograde arc tracks were observed, although not simultaneously. Evidence points to a discharge mechanism composed of multiple current-conducting paths in parallel with the main arc discharge. The net arc motion is independent of current alone above a threshold of ~40 amp. The electrode erosion problem is discussed. (D.L.C.)

2374 ADIABATIC APPROXIMATION AND PARTICLE CONFINEMENT IN MAGNETIC MIRRORS. Michel Trocheris. Cahiers Phys., 16: 221-35(June 1962). (In French)

Starting from the example of the motion of a charged particle in an almost uniform and constant magnetic field, a general adiabatic approximation is developed that is applicable to systems of differential equations that have all solutions nearly periodic. Emphasis is given to the special invariants of the Hamiltonian that lead to a definition of adiabatic invariants. The motion of a particle in a magnetic mirror geometry is considered as an example, up to the second adiabatic invariant. (auth)

2375 SHOCK WAVES IN PLASMA. Paul Germain. Cahiers Phys., 16: 243-60(June 1962). (In French)

The properties and structures of magneto-fluid-dynamic shock waves are outlined. Shock waves in two-component fluids, and collisionless shock waves are investigated. A bibliography of 31 references is included. (auth)

2376 SHOCK WAVES IN A RAREFIED PLASMA LOCATED IN A WEAK MAGNETIC FIELD. S. S. Moiseev and R. Z. Sagdeev. Doklady Akad. Nauk SSSR, 146: 329-32(Sept. 11, 1962). (In Russian)

The formation of a "collision-free" shock wave can occur even at low Mach numbers in the presence of a "non-isotropic" instability. If two groups of particles move in opposite directions along the x axis, a redistribution of particle velocities occurs in an inhomogeneous, perturbed field H. The resulting electric current, directed opposite to the electric field, leads to an increase in the perturbation, if the current created by the electric field itself is the smaller. An anisotropic velocity distribution takes place as the particles enter a new region, and an instability results. The increasing magnetic field traps the particles until the energies are equalized. Thus, a non-spreading type of perturbation is created that has the character of a shock wave at a high enough anisotropy in temperature ($\Delta T > T_{||}$). Here $\Delta T = T_{\perp} - T_{||} > 0$, and $T_{\perp} = (m_i/2)(v_{\perp} - \bar{v}_{\perp})^2$ and $T_{||} = (m_i/2)(v_{||} - \bar{v}_{||})^2$. The term m_i is the mass of the ion, and m_e is the electron mass. The amplitude of the pulsation H_s is given by the following: $H_s \sim \sqrt{(m_e/m_i)}\ \sqrt{nT_e}\ \sqrt{\Delta T/T_{||}}$. This expression corresponds to magnetic fields for which $r_e \sim 1/k_0$ (r_e is the Larmor radius of the electrons). The term $k_0^2 = (\omega_{0i}^2/c^2)\ (\Delta T/T_{||})$. The moving ion collides with the small-scale pulsations, and therefore is slightly deflected. An expression was derived for the width of the shock wave Δ_0. With an initial, frozen-in field H_0 satisfying specified conditions, the width of the shock wave Δ should be on the order of the Larmor radius of the ion in the magnetic field of a perturbation, whose amplitude turns out to be on the order of H_0. Magnetic storms originating from the sun have a sharp front 100,000 to 200,000 kilometers thick, and act like shock waves in an interplanetary gas. With an ion speed of 10^8 cm/sec and a particle density of 10^3 cm^{-3}, the mean free path for collisions is 10^{13} km. This shows that the shock wave can originate only from self-consistent fields in the ionized gas. (TTT)

2377 ON THE REFLECTION AND REFRACTION OF HYDROMAGNETIC WAVES IN IONIZED GAS. [PART] II. Tomikazu Namikawa (Osaka City Univ.). J. Geomagnet. Geoelec., 14: 41-8(1962). (In English)

The reflection and refraction of hydromagnetic waves under a uniform magnetic field are studied, and the results are applied to the propagation of hydromagnetic waves of short period in the exosphere. In a meridian plane, an incident wave is reflected or refracted in the same type of waves. In the equatorial region, the transverse wave can not directly propagate into the lower region from the upper region, while the isotropic wave whose wave normal is perpendicular to the main field or is in a meridian plane can do so. (auth)

2378 ON THE ISOTROPIC HYDROMAGNETIC WAVES IN THE EXOSPHERE. Takashi Okuzawa (Kyoto Univ.). J. Geomagnet. Geoelec., 14: 49-57(1962). (In English)

The propagation of weak hydromagnetic waves in the exosphere between 1×10^3 and 5×10^4 km height levels from the Earth's surface is studied, using simplified models. In the upper atmosphere, the steady magnetic field is a dipole one, and it is, in general, difficult to discuss the wave propagation in such a field. But, in some special regions, an approximate treatment can be permitted. An attempt is made to describe two-dimensional wave fronts in the regions near the geomagnetic equatorial plane and high above the geomagnetic pole, using an approximate height-variation of the Alfvén wave velocity, and it is found that: (1) For the isotropic wave, the shape of wave fronts is the same for both the equatorial and the polar regions. (2) In the upper region above V_a (Alfvén wave velocity) maximum height level, the incident waves with large pitch angle to the zenith are almost reflected, but in the region below V_a maximum height level, the incident waves with any pitch angle have tendency to propagate almost Earthward. (auth)

2379 PLASMA POTENTIAL AND ENERGY DISTRIBUTIONS IN HIGH-ENERGY INJECTION MACHINES. T. K. Fowler and M. Rankin (Oak Ridge National Lab., Tenn.). J. Nucl. Energy, Pt. C, 4: 311-20(Oct. 1962).

Steady state conditions are calculated for the Oak Ridge DCX-2 and similar devices in which a plasma confined by magnetic mirrors is maintained continuously by the injection and trapping of energetic ions. The potential difference ϕ from plasma interior to exterior is determined in the course of the numerical solution of Fokker-Planck equations for ion and electron energy distributions. It is assumed that the only electron source is ionization of neutrals, and trapped ions are lost by charge exchange with neutrals and by Coulomb scattering out of the mirrors. Justification for neglecting cold ions from ionization is discussed. The plasma potential ϕ and also, aside from normalization, the energy distributions are found to depend only on the ion injection energy and the fraction of "burnout" of the neutrals and not directly on absolute magnitudes of neutral pressure or ion injection current. Results are combined with equations governing neutrals to obtain a new DCX-2 performance curve relating injection current to ion density achieved. Enhancement of the charge-exchange loss-rate due to collisional cooling of the ions on electrons neglected in earlier calculations, is found to increase by a factor of < 2 the critical injection current required to reach densities limited only by mirror losses. (auth)

2380 THE OHMIC HEATING OF A MULTICOMPONENT PLASMA. J. A. Wesson (Associated Electrical Ind. Ltd., Aldermaston, Berks, Eng.). J. Nucl. Energy, Pt. C, 4: 321-4(Oct. 1962).

Equations for the drift velocity and rate of heating of each component of an ohmically heated multicomponent plasma are derived using the Fokker-Planck equation. The results are applied to a plasma containing two types of positive ion. (auth)

2381 A GENERALIZATION OF A SUFFICIENT CONDITION FOR HYDROMAGNETIC STABILITY. B. S. Liley (Associated Electrical Ind. Ltd., Aldermaston, Berks, Eng.). J. Nucl. Energy, Pt. C, 4: 325-8(Oct. 1962).

A sufficient condition for the stability of static hydromagnetic equilibria, involving volume current, is derived in terms of the principal curvatures of magnetic surfaces. Cusp-type geometries and the cylindrical inverse pinch are shown to be particular cases in which this condition is satisfied. The stability of the Levitron is discussed in terms of this criterion. (auth)

2382 LONGITUDINAL PLASMA OSCILLATIONS. P. Weissglas (Swedish State Power Board, Stockholm). J. Nucl. Energy, Pt. C, 4: 329-36(Oct. 1962).

Starting from the linearized Vlasov equation, the resonance frequencies of a hot, finite plasma are derived. A finite number of resonances results because of thermal motion. In plane geometry they all lie above the plasma frequency ω_p. When the temperature tends to zero they tend to the well known resonance at ω_p. It is shown that in the presence of binary collisions the amplitude decreases very rapidly with increasing frequency due to Landau damping. However this phenomenon requires binary collisions and does not exist in a strictly collision-free plasma. (auth)

2383 DEVICES FOR GENERATING HIGHLY-IONIZED HYDROGEN PLASMA. J. M. Wilcox, W. R. Baker, F. I. Boley, W. S. Cooper III, A. W. DeSilva, and G. R. Spillman (Univ. of California, Berkeley). J. Nucl. Energy, Pt. C, 337-40(Oct. 1962). (UCRL-10121)

A set of closely related devices for generating a highly ionized hydrogen plasma is described. In each device a hydrogen plasma is created in a cylindrical tube immersed in an axial magnetic field of from 4 to 20 kG. The plasma is formed by a switch-on ionizing wave, driven from an external capacitor bank. In a typical tube 14.6 cm dia. and 86.4 cm long, with a magnetic field of 15 kG, an ion density of $> 5 \times 10^{15}$ cm^{-3} is attained in hydrogen of initial atomic density 6.6×10^{15} cm^{-3}. The temperature of this plasma is between 10,000 and 30,000°K, and the plasma decays in several hundred microseconds by a volume-recombination process. (auth)

2384 LONGITUDINAL SHOCKS IN UNPINCH GEOMTRIES. R. D. Medford, A. L. T. Powell, R. C. Pottinger, and B. Richardson (Atomic Weapons Research Establishment, Foulness, Essex, Eng.). J. Nucl. Energy, Pt. C, 4: 341-6(Oct. 1962).

The propagation of longitudinal shock waves along plasma columns confined by external and internal magnetic fields is analysed. The specific cases of the "unpinch" and "hardcore" geometries are considered and their existence shown in the former case. The use of longitudinal shocks in a linear pinch for diagnostic purposes is demonstrated. (auth)

2385 MATCHING CONDITIONS AT GRADUAL PLASMA BOUNDARIES. D. J. BenDaniel and H. Hurwitz, Jr. (General Electric Research Lab., Schenectady, N. Y.). J. Nucl. Energy, Pt. C, 4: 347-51(Oct. 1962).

The problem of matching the solutions of the wave equation at gradual plasma boundaries has been considered

extensively by several authors. In this note certain of the results are summarized for various simple forms of variation of the isotropic dielectric constant for normally incident waves in the boundary region. Contour graphs of the amplitude of the reflection coefficient as a function of boundary parameters are presented. (auth)

2386 THE EMISSION OF MICROWAVE NOISE BY PLASMA. D. J. H. Wort (Culham Lab., Culham, Abingdon, Berks, Eng.). J. Nucl. Energy, Pt. C, 4: 353-7(Oct. 1962).

The thermal microwave emissivity of a plasma of infinite extend is determined, in which there is a linear gradient of electron number density in the direction of observation. The region in the plasma which contributes most effectively to the radiation is found to lie close to the plane of critical density. The effect of reflecting walls surrounding the plasma is included, and some mention is made of the directional properties of the radiation. A discrepancy between theory and observation appears on consideration of the experimental results from the Zeta plasma. (auth)

2387 COMMENT ON VEKSLER'S ELECTRON ACCELERATION MECHANISM. G. W. Stuart (General Dynamics, San Diego, Calif.). J. Nucl. Energy, Pt. C, 4: 359 (Oct. 1962).

Veksler's mechanism for generating relativistic electrons in cosmic space, in which he considers a cloud of plasma traveling into an increasing, cylindrically symmetric, magnetic field, is considered. It is concluded that any cosmic plasma cloud which persists for longer than one second must be much larger than the Debye distance in interstellar space, and the maximum charge separation potential which can arise is on the order of the ambient electron temperature of 1 ev. Thus it would appear that Veksler's mechanism does not operate because of the ambient electrons. (W.D.M.)

2388 STUDY OF ION TRAJECTORIES IN A MAGNETIC MIRROR CONFIGURATION. B. Leroux and C. Gourdon (Centre d'Études Nucléaires, Paris). J. Phys. Radium, 23: 341-7(June 1962). (In French)

The conditions for temporary capture of charged particles, injected in a magnetic mirror configuration, are studied experimentally with an electron model. From the measured vector potential of the magnetic field, boundary-surfaces (Störmer equipotential surfaces) corresponding to special conditions for injection, are deduced. The trajectories of the injected electrons were measured with probes. Photographs are shown of trajectories with multiple passage through the axis or near the axis. Ranges for the injection parameters for which temporary capture was observed were given. (auth)

2389 THE EFFECT OF RADIATIVE LOSSES ON THE ATTENUATION OF ELECTROMAGNETICALLY DRIVEN SHOCK WAVES. J. A. Thornton and A. B. Cambel (Northwestern Univ., Evanston, Ill.). J. Quant. Spectry. Radiative Transfer, 2: 249-61(1962).

The approximate, one dimensional blast wave theory of Harris is modified to take into consideration the effect of radiation losses from plasmas behind strong shock waves produced in electromagnetic shock tubes. The semi-empirical radiation theory of Kivel is used in evaluating the resulting modified shock expansion equation. The influence of various shock tube operating parameters such as energy input and ambient density on the shock wave velocity attenuation via radiation is examined. The predictions suggested by the proposed theory are confirmed by means of experimental data obtained in a conical discharge section electromagnetic shock tube. It is seen that the most severe effect due to radiative losses occurs near the gaseous discharge. Radiation losses are found to be unimportant at distances downstream of the electrical discharge when the gas density is low. (auth)

2390 METHOD FOR THE CONTROL OF A THERMAL NUCLEAR FUSION. M. Steenbeck. German Patent DWP 21090. Apr. 10, 1961. Kernenergie, 5: 584(July 1962). (In German)

In the control of nuclear fusion in which particle clouds in the accelerating installation were brought to a high kinetic energy, it is proposed that the particle cloud be developed in the manner of cosmic dust, execute extremely turbulent motions, and meet violently from opposing directions in such a way that a fusion is initiated. The particle cloud could contain, as an example, preponderantly lithium or heavy hydrogen. (J.S.R.)

2391 METHOD AND DEVICE FOR A CONTROLLED NUCLEAR FUSION. M. Steenbeck. German Patent DWP 21099. Apr. 10, 1961. Kernenergie, 5: 584(July 1962). (In German)

In the ignition of a controlled thermonuclear fusion by means of gas discharge, it was proposed that dipoles—especially loop dipoles—be arranged on the interior wall of a reaction space and be fed with phase modulated h-f pulses. The emitted transverse waves produce field intensities (power densities) which release a fusion reaction in a centrally placed reaction zone. In the device used for carrying out this method, dipoles are arranged on opposite zones of the reactor vessel, especially at two zones of a cylinder mantle or at a spherical zone. The focal line or the reaction zone surrounding the focal point is cylindrical or spherical in shape and the waves are principally in the centimeter and decimeter range. (J.S.R.)

2392 ON THE THEORY OF THE STABILITY OF CONDUCTING FLUID CYLINDER IN MAGNETIC FIELD. Yu. V. Vandakurov. Priklad. Mat. i Mekhan., 26: 877-84 (Sept.-Oct. 1962). (In Russian)

A hollow incompressible cylinder model was used in investigating tube-shaped plasma pinch stability. It was assumed that azimuthal and axial magnetic field components are present in conducting layers at equilibrium. The stability is studied by linearized magnetohydrodynamic equations. Cases of infinitely strong or weak conductivity in hollow cylinders were analyzed. In the first instance the dispersion equation is expressed by squares of long-wave perturbations resulting in spiral cylinder bends when the longitudinal magnetic fields are close to homogeneous. In the case of weak conductivity, natural oscillations are absent when there is a continuous distribution of current density. Oscillations are observed only in discontinuous conductivity. (R.V.J.)

2393 OPTICAL OBSERVATION OF INSTABILITIES IN THE LINEAR PINCH DURING THE FIRST CONTRACTION PHASE. W. Hertz (Forschungslaboratorium der Siemens-Schuckertwerke AG, Erlangen, Ger.). Z. Naturforsch., 17a: 681-5(Aug. 1962). (In German)

With an optical lens converter camera, sweep and instantaneous pictures were prepared on linear unstabilized pinch discharges in hydrogen. From the sweep pictures it is seen that the plasma layer during the first inlet does not glow equally, but that light channels are present, the formation of which is limited by the return conductor geometry. During the first contraction, instabilities of the $\underline{m} = 0$ type occur with transient amplitudes and wave lengths that can be followed in picture series. Within the measurement accuracy, the amplitude variation observed

agrees with the Wyld theoretical calculations made using the collision wave model, whereas no experimental agreement was found with the single-particle and snow-plow models. (tr-auth)

2394 ON THE "STABILITY" OF THE PLASMA BOUNDARY LAYER. G. Ecker (Univ. of California, Berkeley). Z. Naturforsch., 17a: 705-6(Aug. 1962). (In English)

A theoretical study is made to determine whether there is a stationary solution for the inertia limited region and whether its existence is limited by Bohm's criterion. It is concluded that Bohm's criterion is not a necessary limitation for the boundary layer, and that the inertia limited zone formed when a plasma is bounded by an insulated wall cannot, in general, have a stationary solution. (J.S.R.)

2395 QUANTUM MECHANICAL TREATMENT OF ELECTRIC MICROFIELD PROBLEMS IN PLASMAS. Folker Engelmann (Euratom-CEA, Fontenay-aux-Roses, France). Z. Physik, 169: 126-40(1962). (In English)

Within the framework of a quantum mechanical treatment of electromicrofields in plasmas, some problems were discussed which cannot be solved satisfactorily within the classical framework. It is shown that the asymptotic behavior of the distribution function W(E) of the electrical field strength E for large values of |E| is completely independent of the physical space point and is satisfactorily represented by the simple Holtsmark distribution. The divergence difficulty occurring in the classical correlation function $\langle E\mu(t) \cdot E(t+\tau)\rangle$ for $\tau \to 0$ is solved in the corresponding quantum mechanical expression. (tr-auth)

2396 INVESTIGATION OF ELECTROMAGNETIC PHENOMENA INVOLVED IN THE MOTION OF BODIES IN A CONDUCTING FLUID IN A MAGNETIC FIELD. L. I. Dorman and Yu. M. Mikhailov (Magnetic Lab., Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 43: 752-62 (Sept. 1962). (In Russian)

The motion of a sphere in an incompressible fluid of finite conductivity in an external magnetic field is considered for small magnetic Reynolds numbers and small Stuart numbers. The distribution of the electric and magnetic fields is given under the assumption that the fluid velocity field is potential. The electric field distribution in the boundary layer of the sphere is derived for small Hartman numbers. The electric and magnetic fields produced during the movement of a sphere in mercury are investigated experimentally for Reynolds numbers lying between 5×10^4 and 5×10^5. (auth)

2397 INVESTIGATION OF THE EFFECT OF AN EXTERNAL MAGNETIC FIELD ON THE LIGHT CHARACTERISTICS OF A PULSED DISCHARGE IN HELIUM. S. I. Andreev, M. P. Vanyukov, and A. T. Starovoitov (State Inst. of Optics, USSR). Zh. Eksperim. i Teor. Fiz., 43: 804-7 (Sept. 1962). (In Russian)

The effect of a longitudinal quasistationary field up to 150,000 Oe on the brightness of the column of a pulsed discharge in helium is investigated. It is found that the brightness of a discharge column in a magnetic field increases with the field strength. The plasma conductivity in this case also increases. (auth)

2398 ON DETERMINING THE LIFETIME OF A HIGH TEMPERATURE PLASMA ON BASIS OF THE DURATION OF NEUTRON EMISSION. Yu. V. Gott and V. G. Telkovskii. Zh. Eksperim. i Teor. Fiz., 43: 831-4(Sept. 1962). (In Russian)

The possibility of determining the lifetime of a high-temperature deuterium plasma in an installation with magnetic mirrors on the basis of the neutron emission is investigated. It is demonstrated that if organic scintillators are employed for recording the neutrons, the experimental results may be distorted by γ quanta produced in the scintillator as a result of radiative capture of the slowed-down neutrons. (auth)

2399 HELICAL INSTABILITY OF A TOROIDAL DISCHARGE IN A VARYING MAGNETIC FIELD. A. P. Babichev, A. I. Karchevskii, and Yu. A. Muromkin. Zh. Eksperim. i Teor. Fiz., 43: 881-5(Sept. 1962). (In Russian)

In experiments on the effect of a varying longitudinal field on a toroidal discharge loss of macroscopic stability of the discharge was observed, that is, a helical twisting of the current channel as a whole occurred. The instability sets in after change of the direction of the external longitudinal magnetic field. (auth)

2400 QUASILINEAR APPROXIMATION IN THE KINETICS OF A RAREFIED PLASMA. A. A. Vedenov and E. P. Velikov. Zh. Eksperim. i Teor. Fiz., 43: 963-7 (Sept. 1962). (In Russian)

A set of quasilinear equations is deduced from the equations with a self-consistent field for a rarefied high-temperature plasma. The equations are intended for describing the processes taking place in a weakly turbulent plasma, that is, for the case when the spectral energy density of the plasma oscillations considerably exceeds the thermodynamical equilibrium value but remains much smaller than the plasma particle kinetic energy density. The quasi-linear equation set includes (1) an equation for the averaged distribution function of particles diffusing in phase space under the action of stray fields and (2) an equation for the rate of variation of the spectral energy density of these stray fields due to energy exchange with the particles. (auth)

2401 ON THE STRUCTURE OF NON-LINEAR WAVES IN PLASMA. V. N. Tsytovich (Lebedev Inst. of Physics, Moscow). Zh. Tekhn. Fiz., 32: 1042-9(Sept. 1962). (In Russian)

Propagation of relativistic waves was analyzed. The velocity of weak linear waves was considered relativistic when the dielectric penetrability was close to a unity. Consequently, there was little shift in particles, while in nonlinear waves the particle shift was considerable. The investigation is limited to magnetic and electron stationary wave propagation perpendicular to a magnetic field. (R.V.J.)

2402 CONIC SOURCE OF PLASMOIDS. Yu. S. Azovskii, I. T. Guzhkovskii, B. G. Safronov, and V. A. Churaev (Inst. of Physics and Tech., Academy of Sciences, Kharkov). Zh. Tekhn. Fiz., 32: 1050-4(Sept. 1962). (In Russian)

Comparative studies were made of two conic plasma sources, one with a solid conic reverse current and the other with a multi-thread spiral wound around the discharge chamber acting as a reverse current. The plasma bunches produced had a velocity of 3×10^7 cm/sec and a charged particle density $<10^{12}$ cm^{-3}. (R.V.J.)

2403 DETERMINATION OF PLASMA TRANSPORT COEFFICIENTS BY GRAD'S EQUATION. M. V. Samosokhin. Zh. Tekhn. Fiz., 32: 1055-62(Sept. 1962). (In Russian)

Applications of Grad's method in resolving the linearized kinetic equation for electron distribution in plasma with one type of stationary ions reduces the problem of transfer coefficients to a determination of roots of an infinite linear equation system. The limitations of linearized kinetic equation for current and heat fluxes are evaluated. (tr-auth)

2404 STATIONARY QUASI-ONE-DIMENSIONAL FINITE CONDUCTANCE MAGNETOGASDYNAMIC FLOW. P. I. Krapko. Zh. Tekhn. Fiz., 32: 1063-71(Sept. 1962). (In Russian)

Certain precise solutions are developed for stationary one-dimensional and quasi-one-dimensional magnetogasdynamic, finite conductance flow without considering viscosity and thermal conductivity. The basic equations for a gas-filled tube are extended to a tube with constant cross section and magnetic field, then to tubes with accelerated gas and retarding fields and isothermal gas acceleration without external fields. (R.V.J.)

2405 STRUCTURE OF PULSE DISCHARGE PLASMA JET. L. I. Grechikhin and L. Ya. Min'ko (Inst. of Physics, Academy of Sciences, Minsk). Zh. Tekhn. Fiz., 32: 1072-3 (Sept. 1962). (In Russian)

Typical luminescence scans of supersonic pulse discharge plasma jet space-time intensity variations at the electrode opening are given. Pictures of plasma jet structure as a function of the closed discharge (horizontal) volume and opening diameter in plane electrodes are also given. A shock wave observed at the initial discharge, at a certain distance from the electrode, slowly transformed into an almost periodic structure at the end of the discharge. (R.V.J.)

2406 STRUCTURE OF ARC DISCHARGE IN ARGON. I. LOCAL ELECTRIC CHARACTERISTICS. V. F. Kitaev, V. N. Kolesnikov, V. V. Obukhov-Denisov, and N. N. Sobolev (Lebedev Inst. of Physics, Moscow). Zh. Tekhn. Fiz., 32: 1084-9(Sept. 1962). (In Russian)

Field intensity, radial distribution of charged particles (along the contour line of hydrogen H_β), and temperature were measured in arc discharge in argon-hydrogen mixtures. Radial distributions of electric conductivity and current density were calculated. The calculations utilized new, more precise formulas. An equilibrium plasma (i = 10 to 200 amp) and a nonequilibrium plasma (i = 4 amp) were measured. Current calculations according to j(r) distribution are in good agreement with the factual current. No indications of pinch were found. (tr-auth)

2407 STRUCTURE OF ARC DISCHARGE IN ARGON. II. ARC RADIUS AND RADIAL DISTRIBUTIONS. V. N. Kolesnekov and N. N. Sobolev (Lebedev Inst. of Physics, Moscow). Zh. Tekhn. Fiz., 32: 1090-4(Sept. 1962). (In Russian)

The shape of radial electric conductivity $\sigma(r)$ in argon-hydrogen mixtures was analyzed, and it is shown that it is not a function of the current and hydrogen pressure and is well approximated by the function $\sigma(r) = \exp[-(r/r_{0.5})e \ln 2]$. The selected column radius, $r = r_{0.5}$, is qualified by the condition $\sigma(r_{0.5}) = 0.5 \cdot \sigma_{max}$. The obtained data were used in developing formulas for current, radial distribution of temperature, and heat transfer coefficient. (tr-auth)

2408 MEASUREMENTS OF ELECTRIC CONDUCTIVITY IN GAS JETS. K. V. Donskoi, Yu. A. Dunaev, and A. I. Prokof'ev (Leningrad Ioffe Inst. of Physics and Tech.). Zh. Tekhn. Fiz., 32: 1095-8(Sept. 1962). (In Russian)

An induction method is suggested for measuring electric conductivity and other properties of heated gas jets. The method facilitates measurements in a weak high-frequency field without disturbing the plasma and without demanding special installations within the plasma. Measurements were confined to cylindrical and ring cross-section jets distributed along one axis. At given magnitudes and positions the circuit parameters are functions of the electric conductivity along the cross section and of the circuit supply current frequency. By measuring the circuit parameters at various frequencies it is possible to determine electric conductivity in the cross section. (R.V.J.)

2409 A THEORETICAL INVESTIGATION OF ANNULAR MAGNETOHYDRODYNAMIC FLOW WITH A MOVING BOUNDARY. Dennis Charles Kuzma. Thesis, East Lansing, Michigan State Univ., 1961. 39p.

The problem considered is the laminar, steady flow of a viscous, incompressible, conducting fluid in the annular space between two infinitely long circular cylinders under the action of a radially impressed magnetic field and an axially impressed electric field when the outer cylinder is given a uniform angular velocity. The conditions of the problem reduce the magnetohydrodynamic equations to three equations in pressure, velocity, and magnetic field. One equation gives the pressure variation in the radial direction and the other two equations are coupled equations for the velocity and the magnetic field. These three equations are functions of one variable and may be solved in closed form. In the limiting case where the radii become infinite but their difference remains finite, and there is no velocity of the outer cylinder, the solution becomes Hartmann's flow between infinite parallel plates with a transverse magnetic field and a uniform applied electric field. (Dissertation Abstr., 23: No. 3, 1962.)

2410 MICROWAVE PROPAGATION IN AN OVERDENSE BOUNDED MAGNETOPLASMA. Bernard Wieder. Thesis, Boulder, Univ. of Colorado, 1962. 110p.

The magneto-ionic theory shows that for plane wave propagation along the direction of the magnetic field in a magnetoplasma, a mode of propagation exists when the frequency of the wave is smaller than the electron gyrofrequency of the medium. Electromagnetic waves will propagate in this mode regardless of the magnitude of the plasma frequency. It requires only that the collision frequency of the electrons in the plasma be sufficiently small so that collision damping does not excessively attenuate the waves. This mode of propagation has been used to explain very low frequency "whistles" associated with lightning discharges and very low frequency emissions in the earth's exosphere, and has been called the "whistler mode" by ionosphere physicists. This dissertation describes experiments which attempted to use the properties of this mode of propagation as a diagnostic tool in the hot plasma of the magnetic field stabilized pinch discharges in ZETA. While the experiments succeeded in demonstrating that electromagnetic waves could be made to propagate through the overdense plasma, the detected signals exhibited properties that could not be completely accounted for in terms of the whistler mode theory. Further, wave propagation was detected during periods of the pinch discharge which in no way could be explained by the theory. Starting with basic principles, the wave equations which describe the propagation of the waves through the plasma are derived. The whistler mode properties result from the infinite plane wave solution to the wave equations. In a bounded plasma whose dimensions are large compared with the wavelength in the medium propagation modes exist for which the infinite plane wave solution is a valid approximation; other modes, however, are also allowed, which, if excited, can contribute significantly to the actual fields. To determine the nature of these modes, numerical solutions to a complicated transcendental dispersion relation involving Bessel functions of complex argument were required. These solutions show that a large number of discrete modes are allowed. All the qualitative features of the experimental data are easily explained in terms of

these modes. The conclusion derived from the experimental results and the analysis developed to explain the results is that the detected microwave signals, transmitted through the dense ZETA plasma, are the resultant of a multitude of discrete modes. The whistler mode, defined for our purposes as the infinite plane wave solution to the wave equations for frequencies smaller than the gyrofrequency, can exist in the ZETA plasma only as an approximation to some of the modes of propagation. (Dissertation Abstr., 23: No. 3, 1962)

2411 IMPROVEMENTS IN NUCLEAR FUSION REACTORS. Kenneth William Allen (to United Kingdom Atomic Energy Authority). British Patent 908,020. Oct. 10, 1962.

A fusion reactor carrying out the d-t reaction is described which breeds more tritium than the reaction consumes. The reactor has a Li blanket containing 0.1 to 50% Li^6 and 99.9 to 50% Li^7, and the blanket is irradiated with neutrons of energy ≥5.2 Mev from the reaction to form tritium. (D.L.C.)

2412 DEVICE FOR THE INJECTION OF IONS FOR THERMONUCLEAR PLASMA APPARATUS. François Prévot (to Commissariat à l'Énergie Atomique). Canadian Patent 644,691. July 10, 1962.

An ion injection device for a thermonuclear reactor is designed which is relatively simple and gives a high-intensity sheet of ions. The device comprises an annular ion source and an annular acceleration electrode; the confining magnetic field is contained within the ion source. (D.L.C.)

2413 FUSION REACTOR. Bo Peter Lehnert and Bjorn K. J. Bonnevier. Canadian Patent 648,205. Sept. 11, 1962.

A thermonuclear reactor is designed which has improved plasma-confining properties and reduced plasma losses by collisions. The reactor comprises an annular electrical conductor with spokes extending inward to a support pillar. The spokes convey electric current to the conductor for setting up a magnetic field to confine the plasma within two toroidal surfaces, and two electrodes located in the toroidal surfaces generate an electric field perpendicular to the magnetic field. (D.L.C.)

2414 PLASMA ACCELERATOR. Winfield W. Salisbury (to Zenith Radio Corp.). U. S. Patent 3,059,149. Oct. 16, 1962.

A plasma accelerator is designed for a variety of applications, such as studies of shock waves, thermonuclear reactions, cutting torches, propulsion, etc. The accelerator has magnetic field coils surrounding an evacuated vessel and means for timing the energization of the coils to create a traveling magnetic wave for accelerating the plasma. Several embodiments of the accelerator are described for linear and non-linear acceleration, controlled thermonuclear reactions, and re-entrant acceleration. (D.L.C.)

Shielding

2415 (RIA-62-654) CASTABLE MATERIALS FOR NEUTRON SHIELDS. PART 2. W. M. Veroeven and J. W. McGarvey (Rock Island Arsenal Lab., Ill.). Feb. 20, 1962. 32p. (AD-274686)

The development of elastomeric materials for neutron shields is discussed. Numerous liquid natural, butyl, and polybutadiene rubbers, together with a specially synthesized boron modified, acrylic acid terpolymer were evaluated to determine their curing characteristics and properties pertaining to neutron shields. It was determined that a polybutene extended butyl rubber filled with polyethylene and vulcanized using a quinoid type cure offers the most promise as a room temperature pumpable and curable, high hydrogen density neutron shield matrix. (auth)

2416 (UCRL-10439) TECHNIQUES USED IN SHIELDING CALCULATIONS FOR HIGH-ENERGY ACCELERATORS: APPLICATIONS TO SPACE SHIELDING. Roger Wallace and Charles Sondhaus (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 11, 1962. Contract W-7405-eng-48. 35p.

The prediction for the secondary neutron spectrum produced inside of a thick shield is described. The multiplicity of cascade and evaporation secondaries as well as subsequent moderation of the secondary spectrum is described quantitatively. Experimental thick-target neutron yields, as well as Monte Carlo cascade data, are the basis for these estimates. (auth)

2417 ON THE POSSIBILITY OF USING MODEL EXPERIMENTS TO STUDY SHIELDING PROBLEMS. Sven A. E. Johansson (Univ. of Lund, Sweden). Nucl. Sci. Eng., 14: 196-201(Oct. 1962).

The possible use of models to study gamma radiation penetration of complex shielding configurations is discussed with reference to the limitations. An iron model with 2 to 3 Mev gamma rays may serve as a model of the relative intensities in thick concrete shields. Experiments were carried out in which the penetration of 7-Mev gamma rays through a concrete shield was compared with that of 2.62-Mev gammas through an iron model constructed on a 1 : 5.6 scale. Various shield configurations were studied, including shields with straight holes and holes with bends. The results show excellent correspondence between the spectra. (D.L.C.)

2418 SLIDE-RULE FOR PERFORMING CALCULATION INVOLVING SCREENS TO PROTECT PERSONNEL AGAINST RADIATIONS. Jean Lavie (to Commissariat à l'Énergie Atomique). Canadian Patent 644,977. July 17, 1962.

A slide rule is described for screening calculations, such as the screen thickness, the minimum distance of personnel from the radiation source, and the maximum source intensity for a given screen thickness. The slide rule is based on the solution of an equation having five variables and comprises a fixed rule, a moving slider, and a transparent cursor. The use of the slide rule is described in detail. (D.L.C.)

2419 METHOD FOR THE MANUFACTURE OF SLABS HAVING HIGH RESISTANCE TO HEAT AND RADIOACTIVE RADIATION. Paul Jolly. Canadian Patent 647,790. Sept. 4, 1962.

A method is given for manufacturing slabs, bricks, and other compacted materials having high resistance to both heat and radiation. The method comprises mixing pure anhydrite powder with asbestos fibers, 5 to 10% of a metallic sulfate, 5 to 10% sodium silicate, 3 to 6% HCl, and sufficient alkali-free water to form a moist mixture; molding, rolling, or stamping the mixture; and drying the product. $CaCl_2$ may also be added in amounts of 3 to 6% of the mixture to accelerate the setting process. (D.L.C.)

Theoretical Physics

2420 (JINR-E-1061) REGGE POLES AND PERTURBATION THEORY. B. A. Arbuzov, A. A. Logunov, A. N. Tavkhelidze, R. N. Faustov, and A. T. Filipov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 4p.

The method to evaluate the Regge trajectories starting from the perturbation theory is proposed. (auth)

2421 (UCRL-6959-T) EXTREMIZATION OF ENTROPY PRODUCTION RATES. Laurence S. Hall (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 14, 1962. Contract [W-7405-eng-48]. 6p.

Prigogine's "Principle of Minimum Entropy Production", as well as the complementary maximum entropy production principle were examined from a more basic point of view. Two theorems are provided: absolute maximum entropy configurations can be considered to time-develop from absolute maximum entropy configurations; and for the path connecting configurations of absolute maximum entropy, the entropy production rate is stationary. In Prigogine's theory, the system is assumed near equilibrium, so that if the constraints holding the system away from equilibrium were to be lifted at time t, the condition (equilibrium) at time $t + \Delta t$ would be known. Hence the principle of minimum entropy production determines the expected condition at time t. Conversely, if the maximum entropy configuration is known at time t, the expected condition at $t + \Delta t$ would follow from maximum entropy production rate arguments. (auth)

2422 COMPLEX YUKAWA POTENTIALS. R. W. Lardner (Columbia Univ., New York). Ann. Phys. (N. Y.), 20: 177-83(Nov. 1962).

An investigation is made of a variant of the Yukawa potential for which the scattering amplitude may have no more analyticity in momentum transfer than the Lehmann ellipse. A representation, the generalization of the Mandelstam representation to this case, is written down and unitarity is used to determine the spectral function. (auth)

2423 QUANTIZATION OF TWO-COMPONENT HIGHER ORDER SPINOR EQUATIONS. A. O. Barut and G. H. Mullen (Syracuse Univ., N. Y.). Ann. Phys. (N. Y.), 20: 184-202(Nov. 1962).

A two-component fermion field is quantized using a Lagrangian formalism containing higher-order derivatives of the field variables and an indefinite metric in Hilbert space. A consistent quantization necessitates, beside a massive spin-one-half field obeying the Feynman-Gell-Mann equation, the introduction of a massless spin-one-half field obeying the neutrino equation. Gauge-invariant electromagnetic and vector interactions are introduced in a manner that depends on the transformation properties of the field variables. The physical restrictions placed on the S-matrix by the use of an indefinite metric eliminate the massless field from the "composite" field for electrodynamics and pseudo-vector meson interactions, and implies parity invariance except for four-field weak interactions. The results obtained for quantum electrodynamics are equivalent to the four-component theory. (auth)

2424 ACTION PRINCIPLE FOR HIGHER ORDER LAGRANGIANS WITH AN INDEFINITE METRIC. A. O. Barut and G. H. Mullen (Syracuse Univ., N. Y.). Ann. Phys. (N. Y.), 20: 203-18(Nov. 1962).

A consistent action principle with an indefinite metric and a Lagrangian of any finite order requires that the Lagrangian be invariant under an operation called metric conjugation. This in turns implies that an observable must commute with the metric operator, that the S-mstrix must be unitary, and that transitions between states of opposite metric parity are forbidden. For higher order Lagrangians the energy is the 00-component of the energy-momentum tensor. It is necessary to split the derivatives of the field variables into normal and tangential components so that canonical conjugate variables can be defined. (auth)

2425 ELEMENTARY SOLUTIONS OF THE LINEARIZED GAS-DYNAMICS BOLTZMANN EQUATION AND THEIR APPLICATION TO THE SLIP-FLOW PROBLEM. Carlo Cercignani (Gruppo Ricerche e Applicazioni Scientifiche, Milan). Ann. Phys. (N. Y.), 20: 219-33(Nov. 1962).

A method for treating problems involving the gas-dynamics Boltzmann equation is developed. It is analogous to a particular method for the solution of the neutron transport equation. The elementary solutions have separated variables. Problems at a constant temperature are considered. Besides the general theory of pure shear problems in unidimensional plane geometry, a solution of the slip-flow problem is given as an illustration. An analytical expression of the slip-flow coefficient, particularly suitable to a numerical calculation, is thus obtained. (auth)

2426 A SEMIEMPIRICAL METHOD FOR THE CALCULATION OF THE SLATER—CONDON PARAMETERS. Neal F. Lane and Chun C. Lin (Univ. of Oklahoma, Norman). Ann. Phys. (N. Y.), 20: 234-9(Nov. 1962).

A semiempirical method for calculating the Slater-Condon parameters for the atoms of the first transition group is presented. This method is based on the use of effective nuclear charges, which are determined from experimental ionization potential data. The calculated Slater-Condon parameters agree with the experimental values. Applications to the complex ions of the transition elements are discussed. (auth)

2427 THE EÖTVÖS EXPERIMENT, SPATIAL ISOTROPY, AND GENERALLY COVARIANT FIELD THEORIES OF GRAVITY. J. Peebles (Princeton Univ., N. J.). Ann. Phys. (N. Y.), 20: 240-60(Nov. 1962).

It is suggested that the numerical value of the fine structure "constant" may in fact be variable, being determined by the distribution of matter in the universe. However, there is reason to believe that this conjecture is not consistent with the observed structure independence of gravitational acceleration and tests of spatial isotropy. This conjecture is studied within the framework of a classical, generally covariant field theory. The electromagnetic-field equations are modified so that the value of the fine structure constant that would be found from a local experiment is given by a scalar gravitational field. With these modified equations, a field theory of gravity in which the motion of free test particles is consistent with the observed structure independence of gravitational acceleration may be constructed in a straightforward way. However, it is shown that this theory must be ruled out by the experimental observations of spatial isotropy. (auth)

2428 GREEN'S FUNCTIONS FOR FERMION SYSTEMS WITH PAIRING CORRELATIONS. Donald H. Kobe and Warren B. Cheston (Univ. of Minnesota, Minneapolis). Ann. Phys. (N. Y.), 20: 279-305(Nov. 1962).

A canonical transformation is used to transform the Hamiltonian for a system of interacting fermions into that for a system of quasi-particles in which an important part of the pairing interaction is absorbed into the free quasi-particle. Field-theoretic Green's functions, which do not in general conserve the number of quasi-particles, are introduced to treat the interaction between the quasi-particles. These Green's functions are shown to satisfy an infinite set of coupled integral equations, which can be conveniently represented graphically. The infinite set of equations can be terminated by neglecting the interaction Hamiltonian above some arbitrarily chosen equation. The Green's function equations are then solved in the special case where the sum of quasi-particles created and anni-

hilated is four, neglecting self-energy terms, and using a pairing-plus-Coulomb interaction of the superconductivity type. A secular equation for the energy eigenvalues is obtained, and is examined for the cases of no pairing interaction and no Coulomb interaction. When the Coulomb interaction alone is present the secular equation becomes that obtained for plasmons. When the pairing interaction alone is present, the energy spectrum for excitons (bound pairs of quasi-particles) is obtained. It is shown that one of the excitons is a phonon. (auth)

2429 APPROXIMATING TWO-ELECTRON ATOMIC ENERGIES USING SCALED EIGENFUNCTIONS: SEMI-EMPIRICAL COULOMB-REPULSION INTEGRALS. Frank O. Ellison (Carnegie Inst. of Tech., Pittsburgh). J. Chem. Phys., 37: 1414-17(Oct. 1, 1962).

If all electron coordinates in an exact atomic eigenfunction are multiplied by a scaling factor, the kinetic, potential and total energies are modified. Exact equations are derived for these changes. The one-electron energy for a two-electron atom is approximated using scaled one-electron eigenfunctions leading to a semi-empirical estimate of the (1s1s : 1s1s) Coulomb-repulsion integral. Finally, two-electron atomic energies are approximated using scaled eigenfunctions for the corresponding one-electron atom and a two-electron atom of different nuclear charge. (auth)

2430 ON SMALL-ANGLE CRITICAL SCATTERING. H. L. Frisch and G. W. Brady (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys., 37: 1514-21(Oct. 1, 1962).

Recent theoretical studies of simplified models of cooperative assemblies of atoms or molecules suggest that the pair correlation function G(r) at the critical is not given by the Ornstein-Zernike (O.Z.) expression but that this relation becomes asymptotically valid for large distances r away from the critical. Based on some further heuristic considerations, it is suggested that the low-angle scattering of radiation or particles from real three-dimensional cooperative assemblies at the critical composition and temperatures, above but near the critical is essentially given by the Fourier transform of a G(r) which is an interpolation between the O.Z. expression and the critical G(r) suggested by the simplified models. Thus the form of the relative, reduced small angle scattering intensity is derived, and in what ways departures from the O.Z. predictions are expected and their magnitudes are indicated. These calculations may possibly explain certain small but systematic anomalies observed in small angle x-ray scattering from critical binary fluid mixtures. In a particular instance it is thus shown that the apparent linearity of an O.Z. plot (reciprocal intensity versus essentially the square of the scattering angle) is not sufficient evidence for the validity of the O.Z. theory at the critical point. The possibility of two types of clustering ("ferromagnetic" and "anti-ferromagnetic") in binary mixtures are pointed out, and the usefulness of the Zimm cluster integral as a measure of the first type in clarifying the interpretation of scattering data is indicated. The possibility of "critical cluster" formation is discussed briefly. (auth)

2431 ON FEYNMAN QUANTIZATION. S. S. Schweber (Massachusetts Inst. of Tech., Cambridge). J. Math. Phys., 3: 831-42(Sept.-Oct. 1962). (TID-14603)

The observation that in the space of the $a = (1/\sqrt{2})(p + iq)$ variables, the Feynman integral can be defined in terms of a Gaussian measure, forms the basis of a presentation of the Feynman formulation of nonrelativistic quantum mechanics. The extension of this formulation to the case of a Bose field is sketched. (auth)

2432 ON COVARIANT FORMULATIONS OF THE MAXWELL-LORENTZ THEORY OF ELECTROMAGNETISM. Mendel Sachs (McGill Univ., Montreal) and Solomon L. Schwebel. J. Math. Phys., 3: 843-8(Sept.-Oct. 1962).

Maxwell's equations are formulated in a number of different representations, namely: as a single four-component spinor equation whose transformation properties are almost identical with those of the Dirac equation; as a pair of uncoupled two-component spinor equations, in two different representations (one of which is similar to the Weyl equation for the neutrino field and the other to the two-component spinor form of the Dirac equation), and as a single equation in which the field variables are 2×2 matrices. In terms of these field variables corresponding conservation laws are derived. These conservation laws are identified. The transformations that are appropriate to the maintainance of covariance of the field equations are discussed. (auth)

2433 THE PRIMITIVE DOMAINS OF HOLOMORPHY FOR THE 4 AND 5 POINT WIGHTMAN FUNCTIONS. A. C. Manoharan (Brandeis Univ., Waltham, Mass.). J. Math. Phys., 3: 853-9(Sept.-Oct. 1962).

A method is given for estimating the dimensions of different types of boundary surfaces that are relevant for the domains of holomorphy, without using local commutativity, of the 4- and 5-point Wightman functions in scalar product space. The procedure is a straightforward application of the explicit parametrization for vectors on the boundary. The DANAD and other hypersurfaces for the 4-point function are deduced. For the 5-point function, in addition to generalizations of hypersurfaces corresponding to lower point functions, a new type of hypersurface appears which can be denoted in a matrix form Z = DUMUD but not in the form Z = DANAD. (auth)

2434 HEISENBERG FIELDS WHICH VANISH ON DOMAINS OF MOMENTUM SPACE. O. W. Greenberg (Univ. of Maryland, College Park). J. Math. Phys., 3: 859-66 (Sept.-Oct. 1962).

If a local Heisenberg field vanishes, or where appropriate has an infinite zero, on certain momentum-space domains, then the field is shown to be a generalized free field. Counter examples show that this conclusion cannot be drawn if the field vanishes on certain other momentum-space domains. It follows that if two fields in the same Borchers class are equal on one of certain domains, then the fields differ at most by a generalized free field in their Borchers class. (auth)

2435 NONRELATIVISTIC S-MATRIX POLES FOR COMPLEX ANGULAR MOMENTA. Roger G. Newton (Indiana Univ., Bloomington). J. Math. Phys., 3: 867-82 (Sept.-Oct. 1962).

The introduction of complex angular momenta is studied. The shape and number of trajectories of S-matrix poles as functions of the energy is investigated, with particular attention to the way they leave the real axis, and to their ends at $E \to \pm\infty$. The conditions are found under which the S matrix is meromorphic even in Re $l < -\frac{1}{2}$. Some properties of the S matrix in the left half-plane are discussed, as are its symmetry between left and right half-planes, its branch point at E = 0, and the residues at its poles. (auth)

2436 SPECTRAL THEORY OF DIRAC'S RADIAL RELATIVISTIC WAVE EQUATION. B. W. Roos and W. C. Sangren (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Math. Phys., 3: 882-90(Sept.-Oct. 1962).

The analytical methods developed for the study of the

Sturm-Liouville equation are extended to the investigation of the spectral properties of the Dirac radial wave equation. It is shown how a limit-point, limit-circle theorem may be generalized to include the singular cases of a system of two first-order differential equations. A transformation is introduced and order properties are established for the solution of the corresponding integral equations. The nature of the spectrum is discussed for specific singular potentials. (auth)

2437 BEHAVIOR OF ASYMPTOTICALLY FLAT EMPTY SPACES. Ezra T. Newman and Theodore W. J. Unti (Univ. of Pittsburgh). J. Math. Phys., 3: 891-901 (Sept.-Oct. 1962).

The asymptotic behavior of the Weyl tensor and metric tensor is investigated for (probably) all asymptotically flat solutions of the empty-space Einstein field equations. The systematic investigation utilizes a set of first-order differential equations, which are equivalent to the empty space Einstein equations. These are solved asymptotically, subject to a condition imposed on a tetrad component of the Riemann tensor Ψ_0 that ensures the approach to flatness at spatial infinity of the space-time. If Ψ_0 is assumed to be an analytic function of a suitably defined radial coordinate, uniqueness of the solutions can be proved. However, progress is made toward establishing a rigorous proof of uniqueness in the nonanalytic case. A discussion of the remaining coordinate freedom, with certain topological aspects, is also included. (auth)

2438 EMPTY SPACE METRICS CONTAINING HYPERSURFACE ORTHOGONAL GEODESIC RAYS. Ezra T. Newman and Louis A. Tamburino (Univ. of Pittsburgh). J. Math. Phys., 3: 902-7(Sept.-Oct. 1962).

All empty-space metrics that possess hypersurface orthogonal geodesic rays with nonvanishing shear and divergence are obtained. By straightforward integration of the Newman-Penrose equations, which are equivalent to the Einstein equations, all solutions are found in closed form and are unique up to a few arbitrary constants. The method of integration is illustrated in detail for certain solutions. (auth)

2439 ON THE CHARACTERISTIC INITIAL VALUE PROBLEM IN GRAVITATIONAL THEORY. R. K. Sachs (U. S. Army Signal Research and Development Lab., Fort Monmouth, N. J.). J. Math. Phys., 3: 908-14(Sept.-Oct. 1962).

The problem of determining a solution of the Einstein field equations for the gravitational field from data set on a pair of intersecting characteristic (that is, null) hypersurfaces and on their intersection Σ is considered. It is shown that by giving the conformal inner metric of each hypersurface, the inner geometry of Σ, the two mean extrinsic curvatures of Σ, and one additional extrinsic quantity for Σ, a solution in a space-time region is completely determined. In a suitable coordinate system, giving the above data amounts to giving four functions of three variables, four functions of two variables, and one function of one variable; all these can be given without any constraints. In a given space-time with given Σ the functions are almost, but not entirely, known functions of their arguments. All the derivations and discussions are applicable only in a sufficiently small four-dimensional region. (auth)

2440 A NOTE ON THE SCATTERING OF BOSON FIELDS. David Shale (Univ. of California, Berkeley). J. Math. Phys., 3: 915-21(Sept.-Oct. 1962).

A physically operational and mathematically simple definition is given for the convergence of states for a boson field. The relevant formulation of the scattering matrix is discussed. As an example, the scattering of a free boson field by a given linear time-independent unquantized source is treated. It is shown that cases usually called "infrared" and "ultraviolet," castastrophes are actually convergent. (auth)

2441 COMPLEX ANGULAR MOMENTA IN POTENTIAL SCATTERING. Marcel Froissart (Princeton Univ., N. J.). J. Math. Phys., 3: 922-7(Sept.-Oct. 1962).

The S matrix associated with a central potential is shown to be meromorphic in the energy and angular momentum variables under very broad conditions. The domain of meromorphy contains the product of a domain in the energy variable by a domain in the angular variable. The former (latter) domain has a very simple connection with the domain of meromorphy of the Laplace (Mellin) transform of the potential with respect to the radius. (auth)

2442 EXACT EIGENFUNCTIONS OF ANGULAR MOMENTUM BY ROTATIONAL PROJECTION. J. K. Percus and A. Rotenberg (New York Univ., New York.). J. Math. Phys., 3: 928-32(Sept.-Oct. 1962).

By an appropriate rotational procedure, a projection operator can be constructed to give exact eigenfunctions of angular momentum. Applications to cases involving spin and orbital angular momentum are given and, in particular, all spin multiplets of the alternant molecular structure are obtained. The connection with the group theoretical approach is discussed. (auth)

2443 ON A PAPER OF GREEN AND LANFORD. S. T. Kuroda (Univ. of California, Berkeley). J. Math. Phys., 3: 933-5(Sept.-Oct. 1962).

The phase shift formulas for the wave and scattering operators in the potential scattering of a single nonrelativistic particle are proved, under weak assumptions on the potential. (auth)

2444 INTRODUCTION TO MOMENTUM SPACE INTEGRATION TECHNIQUES IN PERTURBATION THEORY. M. Fowler (Cambridge Univ., Eng.). J. Math. Phys., 3: 936-45(Sept.-Oct. 1962).

Generalized "pinch" techniques are developed for analyzing singularity configurations of any Feynman integral in the product space of the loop momenta. The Landau equations follow immediately, and the dual diagrams arise naturally as geometric singularity criteria. Cutkosky's formula for the discontinuity is derived by an elementary method, and its structure is clearly exhibited by this approach. The basic differences between Landau and non-Landau singularities for single loop diagrams are discussed, and it is shown why the presence of non-Landau singularities, in contrast to those in the Landau scheme, depends on the dimensionality of space. (auth)

2445 ASYMPTOTIC PROPERTIES OF THE WAVE FUNCTION FOR A BOUND NONRELATIVISTIC THREE-BODY SYSTEM. E. Leo Slaggie (Columbia Univ., New York) and Eyvind H. Wichmann. J. Math. Phys., 3: 946-68 (Sept.-Oct. 1962).

The asymptotic properties of a Schrödinger wave function that represents the bound ground state of a system of three interacting particles are examined. It is assumed that the interaction can be described by a static potential that is the sum of three two-body potentials and one three-body potential, where the potentials have the property that if any one of the particles is separated from the other two by a distance that tends to infinity, then the part of the potential energy that depends on the position of that particle tends to zero. The problem is treated nonrelativistically. Decreasing exponential bounds on the ground-state three-body wave function are established in configuration space. It is

shown that these bounds depend only on the masses of the three particles, on the ground-state energy of the three-body system, and on the lower bounds on the spectra of the Hamiltonians for the three two-body systems arising when one of the three particles is removed and the remaining two interact through the corresponding two-body potential. It is furthermore shown that the three-body wave function in momentum space admits of analytic continuation into a tube-region in complex momentum space, which tube-region is the product of real momentum space and a convex bounded region in imaginary momentum space. The tube-region is explicitly determined. The implications of the results for the theory of the vertex function in quantum field theory are discussed. The relevance of the results obtained to the variational computation of energy levels and wave functions of three-body systems is also briefly discussed. In the course of the derivation some generalizations are pointed out; in particular, the final results remain valid for a class of general interactions, which cannot be described by static potentials. Likewise, the results remain valid for a class of spin-dependent interactions. (auth)

2446 STUDIES IN PERTURBATION THEORY. IV. SOLUTION OF EIGENVALUE PROBLEM BY PROJECTION OPERATOR FORMALISM. Per-Olov Loewdin (Univ. of Uppsala and Univ. of Florida, Gainesville). J. Math. Phys., 3: 969-82(Sept.-Oct. 1962).

The partitioning technique for solving secular equations is reviewed. It is formulated in terms of an operator language in order to permit a discussion of the various methods of solving the Schrödinger equation. The total space is divided into two parts by means of a self-adjoint projection operator O. Introducing the symbolic inverse $T = (1 - O)/(E - H)$, it can be shown that there exists an operator $\Omega = O + THO$, which is an idempotent eigenoperator to H and satisfies the relations $H\Omega = E\Omega$ and $\Omega^2 = \Omega$. This operator is not normal but has a form that directly corresponds to infinite-order perturbation theory. Both the Brillouin- and Schrödinger-type formulas may be derived by power series expansion of T, even if other forms are perhaps more natural. The concept of the reaction operator is discussed, and upper and lower bounds for the true eigenvalues are derived. (auth)

2447 VARIATIONAL FORMULATIONS OF EQUILIBRIUM STATISTICAL MECHANICS. Cyrano De Dominicis (Harvard Univ., Cambridge, Mass.). J. Math. Phys., 3: 983-1002(Sept.-Oct. 1962).

Thermodynamical functions for classical and quantum systems are expressed in terms of the one-particle density n_1 and the two-particle correlation matrix C_{12} (or quantities in direct relation to them). Use is made of topological relations valid for the diagram representations of the grand partition function expansions. The result considered as a functional of n_1 and C_{12} is stationary under independent variations δn_1 and δC_{12}. In particular, the entropy functional of a classical system no longer contains any reference to the equilibrium parameters (or to the interactions) and the second functional derivative is a negative definite matrix. The entropy functional of a quantum system conserves traces of the equilibrium parameters in the Lee-Yang formulation, but not in the Green's-function formulation. In the latter case, however, the second functional derivative is no longer a negative definite matrix. (auth)

2448 ANALYTIC PROPERTIES OF THE QUANTUM CORRECTIONS TO THE SECOND VIRIAL COEFFICIENT. Hugh E. DeWitt (Univ. of California, Livermore). J. Math. Phys., 3: 1003-16(Sept.-Oct. 1962). (UCRL-6611)

The use of the perturbation expansion and the Wigner-Kirkwood expansion of the quantum-mechanical partition function is discussed for various interaction potentials. It is shown that, contrary to what is expected from the Wigner-Kirkwood expansion, quantum-mechanical diffraction corrections at high temperature to the classical partition function may involve nonanalytic forms of $\hbar^2$. This can occur when the second-order perturbation term is finite in the classical limit, and the interaction potential has a cusp or singularity in any derivative. The second-order perturbation term is evaluated exactly for the exponential, screened Coulomb, and square barrier potentials, and the nonanalytic form $(\hbar^2)^{3/2}$ is found. For potentials more singular than $1/r$ at the origin, the diffraction corrections are analytic in $\hbar^2$. A method of deriving the Wigner-Kirkwood expansion from the perturbation expansion is given. The method allows the subtraction of any order of the perturbation expansion that can be evaluated separately, and is particularly useful for the screened Coulomb potential. The classical second virial coefficient and the $O(\hbar^2)$ and $O(\hbar^4)$ diffraction corrections are evaluated for the singular potential, $u(r) = (g_p/r^p)e^{-r/r_0}$, by using the Mellin transform of e^{-x_0}. (auth)

2449 DERIVATION OF GENERALIZED MASTER EQUATIONS. Robert J. Swenson (Lehigh Univ., Bethlehem, Penna.). J. Math. Phys., 3: 1017-22(Sept.-Oct. 1962).

We present a derivation of a generalized master equation for the diagonal part of the occupation probability density. This derivation is valid for systems of arbitrary volume. It does not require the use of perturbation expansions nor the use of a diagonal singularity condition. In addition, a similar derivation is presented of a generalized master equation for the nondiagonal part of the occupation probability density. These equations become identical to certain other generalized master equations if a perturbation expansion is made, if a diagonal singularity condition is assumed, and if the limit of infinite volume is taken. (auth)

2450 EXACT SOLUTION FOR THE VIBRATIONS OF A NONLINEAR CONTINUOUS MODEL STRING. Norman J. Zabusky (Bell Telephone Labs, Inc., Whippany, N. J.). J. Math. Phys., 3: 1028-39(Sept.-Oct. 1962). (MATT-102)

An exact solution is given for the partial differential equation $y_{tt} = [1 + \epsilon y_x]^\alpha y_{xx}$, which describes the standing vibrations of a finite, continuous, and nonlinear string. The nonlinearity studied, $[1 + \epsilon y_x]^\alpha$, is motivated by reports on numerical studies of the "equipartition of energy" in nonlinear systems. To obtain the solution, the above equation is transformed into a linear equation by inverting the roles of the dependent ($u = y_x$ and $v = y_t$) and independent (x and t) variables. Riemann's method of integration is applied to the problem and the solutions for t and x are written as integrals. The nature of the "inverse Riemann plane," how it is related to the initial conditions, and how it can be unfolded, are discussed. A general procedure is described for reinverting the solution, so that y can be written as a function of x and t. It is illustrated to order ϵ for the above problem. It is demonstrated that y_{xx} becomes singular, that is, y_x develops a discontinuity after an elapsed time of order $(1/\epsilon)$. The methods described are applicable to any nonlinear string where the coefficient of y_{xx} is a function of y_x only. The effect of higher spatial derivatives on the formation of the singularity is discussed. (auth)

2451 PROOF OF A CONJECTURE BY DYSON. Kenneth G. Wilson (Harvard Univ., Cambridge, Mass.). J. Math. Phys., 3: 1040-3(Sept.-Oct. 1962).

A mathematical conjecture used in a study of the statisti-

cal distribution of energy levels in complex nuclei is proved. (auth)

2452 NORMAL FORMS OF COMPLEX MATRICES. Bruno Zumino (New York Univ., New York). J. Math. Phys., 3: 1055-7(Sept.-Oct. 1962).

Simple normal forms are given for symmetric, skew-symmetric, and general complex matrices. These three cases can be combined into a single one, if matrices with elements in a suitable ground field are considered. (auth)

2453 A REDUCTION OF THE MANY-BODY PROBLEM OF SOLID-STATE PHYSICS TO PARTIAL SYSTEMS FOR ELECTRONS AND LATTICE. Guenter Sauermann (Technische Hochschule, Munich). Z. Physik, 169: 198-218(1962). (In German)

The solid body was considered as a coupled system of electrons and nuclei with Coulomb interaction, and it was assumed that the smaller the probability for a distribution of the electron pulse, the more the electron pulses lie outside the Fermi sphere. With these assumptions, the eigenvalue equation of the total Hamilton operator can be reduced, by consideration of the large mass difference of electrons and nuclei, to two simple eigenvalue equations, that is, to a single particle equation for one particle with electron mass and to an equation which contains only the nuclear variables. Both eigenvalue equations can be interpreted as equations for quasi-particles for "bound electrons" and "lattice particles," in which the latter is composed of bound electrons and a nucleus. In the representation of the quasi-particles, the total system was described by the motion of the bound electrons about the nucleus and the relative motion of the lattice particles to each other. A still-remaining energy term in the total energy can be assigned additional quasi-particles, the "free electrons." The approximation carried out therefore represents clearly a decomposition of the solid-body problem into lattice particles, bound and free electrons. (tr-auth)

2454 SUM RULES IN THE THEORY OF FERMI LIQUIDS. W. Brenig (Technische Hochschule, Munich). Z. Physik, 169: 219-23(1962). (In English)

An equation for the time dependent pair correlation on its Fourier transform, the response function, is derived within the framework of Landau's theory of Fermi liquids. The conditions for the validity of the optical sum rule are investigated. An "elastic" sum rule relating the response function to the compressibility is formulated and its proof indicated. (auth)

2455 INFRARED ASYMPTOTICS OF THE GREEN'S FUNCTION IN SOME QUANTUM FIELD THEORY MODELS. G. A. Milekhin (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 43: 1012-20(Sept. 1962). (In Russian)

The infrared asymptotics of single-particle Green's functions are investigated for certain types of interactions by the continual integration method. It is demonstrated that under some conditions, the first term of the asymptotic expansion is determined only by low energy virtual processes, whereas the subsequent terms significantly depend on high energy virtual processes. It is also shown that pseudoscalar interaction between mesons and nucleons is weak in the infrared region. (auth)

2456 REPRESENTATIONS OF THE COMMUTATION RELATIONS DESCRIBING A NON-RELATIVISTIC INFINITE FREE BOSE GAS. Edward James Woods. Thesis, Princeton, N. J., Princeton Univ., 1962. 122p.

The existence of representations of the canonical commutation relations (CCRs) which describe a non-relativistic Bose gas of uniform density is investigated, with a view to possible applications to statistical mechanics. The functional $E(f,g) = (\psi, e^{i\Phi(f)} e^{i\pi(g)}\psi)$ is used to describe a representation of the CCRs. This functional is calculated for the free Bose gas in a box of volume V, and the limit is then taken as $V \to \infty$. It is shown that the resulting E(f,g) satisfies the necessary conditions to define a representation of the CCRs. These representations are labeled by a density distribution ρ (k) in momentum space. They are irreducible if and only if there is no macroscopic occupation of any single quantum state. For the free Bose gas, it is argued that to each density ρ and temperature T there corresponds one inequivalent representation of the CCRs, and that the density matrix which describes a system in thermal equilibrium is a pure state. However, no prescription is given for selecting the appropriate representations. The results are described qualitatively and technically. The inequivalence of representations and other abstract mathematical concepts are discussed in the simpler context of the quantum theory of systems with finitely many degrees of freedom. A discussion is given of the general theory of the representations of the CCRs. As a preliminary step, these methods are applied to the Fock representation. Finally, inequivalent representations which describe an infinite free Bose gas are constructed. A brief statement of the present status of the problem is given. (Dissertation Abstr., 23: No. 3, 1962)

REACTOR TECHNOLOGY

General and Miscellaneous

Refer also to abstracts 1892, 1902, 1909, 1959, and 2205.

2457 (AHSB(S)R-31) A DISCUSSION OF SOME CONTROL RECOMMENDATIONS FOR STAGE 1 GAS COOLED REACTORS. M. J. Cowper and D. Wray (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, Risley, Lancs, England). Aug. 8, 1962. 14p.

The main safety requirement for Stage 1 gas-cooled reactors is to prevent the release of fission products by a protection requirement which preserves the integrity of the fuel canning, pressure vessel, and circuit. Some of the principles applicable to the preservation of the integrity of the fuel canning are stated, and some of the resulting practices are discussed. The control systems necessary to maintain the working conditions of the fuel elements to within safe limits and the reason an automatic shut-down system is considered necessary to provide adequate protection are discussed. The design limitations to be placed on reactor control systems, so that faults therein do not result in a reactor excursion which is either too fast or too large for the capability of the protective system, were investigated. In addition, since practical and economic considerations prevent the protection of every channel of fuel in the reactor, the necessary constraints to be placed on the control systems so that localized areas of excessive temperature cannot occur are discussed. In order to achieve an acceptable level of reliability of operation of the automatic protection system itself, it is shown that a redundant system using coincident working should be used in conjunction with a suitable proof testing procedure to maintain the redundancy. Typical failure rates of protective equipment are mentioned as target figures which, when used in a suitable redundant system, should enable a practical proof test period to be chosen to achieve the desired level of reliability. In order to achieve a similar high level of likelihood of incident detection it is argued that each incident requiring protective action should be detected by at least two independent parameters, one of which should preferably be fuel can temperature. The limitations and acceptable exceptions to this principle are also discussed. The principles applicable to ensure that the shut-down mechanisms themselves are equally reliable are stated and limitations placed on their number, size, and rate of operation. Some safety principles applicable to the human controller, emphasizing the limitations of administrative control and defining the limitations of safety which can be claimed by the use of interlocks, are listed. (auth)

2458 (BMI-X-10015) A STUDY OF ROTARY SHAFT-SEALING CONCEPTS FOR PRESSURIZED-WATER REACTOR APPLICATION. Quarterly Progress Report, July-September 1962. C. M. Allen and John W. Kissel (Battelle Memorial Inst., Columbus, Ohio). Oct. 1, 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract W-7405-eng-92. 9p. (EURAEC-452)

The design of apparatus to investigate face and stuffing box seals for rotary shaft-sealing in pressurized water reactors is briefly described. (R.J.S.)

2459 (BNL-731) NUCLEAR ENGINEERING DEPARTMENT PROGRESS REPORT, JANUARY 1–APRIL 30, 1962. Jean H. Reynolds, ed. (Brookhaven National Lab., Upton, N. Y.). Contract [AT(30-2)-Gen-16]. 105p.

A total of 6 sections are included in the report. A separate abstract was prepared for each section. (J.R.D.)

2460 (BNL-731(p.1-17)) REACTOR PHYSICS DIVISION. (Brookhaven National Lab., Upton, N. Y.).

Review papers on the correlation of theory and experiment for U–H_2O lattices were completed. The theoretical results, based strictly on available cross sections and rigorous calculations, generally yield slight overestimates of criticality. Progress is also reported in areas of power reactor concepts, reactor dynamics, Graphite Research Reactor support, and resonance absorption of neutrons. Calculations were carried out in support of the AEC program on the liquid fluidized bed reactor and were continued on the "cold moderator" concept for high-conversion-ratio, Pu-fueled, thermal reactors. With large clusters of variable enrichment, Pu-fueled rods in a cold, internally pressurized, D_2O-moderated core, these reactors have initial conversion ratios greater than unity. The first bare U-graphite assembly was brought critical during the period. Measurements were performed on the UO_2 lattice with nominal water to oxide volume ratio of 3:1. Bucklings were measured at increasing poisons. Experimental techniques pertinent to resonance escape probability measurements and the measurement of ρ_{28} were carried out with the miniature lattice. A slow neutron chopper was assembled and checked out on the 4 × 4-ft graphite thermal column of the Neutron Source Reactor. Efforts to prepare a revision of BNL 400 ("Neutron Cross Sections–Angular Distributions") were continued. The optical model of the nucleus was applied to obtain a satisfactory fit to experimental data on inelastic neutron scattering by U^{238}. Also, using the optical model, a systematic computation of the transmission coefficients of all nuclei was completed, the results of which will be made available for general use in estimations of neutron cross sections. Consistency between optical model predictions and cross sections averaged over neutron resonances was improved. An understanding of the apparent "repulsions" of nuclear and atomic energy levels is being gained. The evaluation of the Fast Settled Bed Reactors has continued. Out-of-pile testing of UC spherical particles was initiated. The design of an in-pile capsule and thimble for irradiation in the Graphite Research Reactor was completed and fabrication will be initiated shortly. Reactor physics and economic calculations were continued and preliminary results in these two areas were obtained. Criticality calculations for the pulsed plasma reactor indicate that plasma densities required for criticality in poisoned systems are too large for an appreciable diamagnetic effect; hence, a nondiamagnetic plasma was accepted for the analysis. A linear perturbation analysis is being used for a first estimate of power output and efficiency for various conditions. Evaluation of various nonaqueous electrolytes for use in a thermally regenerated fuel cell was undertaken. Analysis was also extended to other types of electrochemical cells. The design of two chemonuclear reactor systems for production of CO in a CO_2 process steam was continued. Particular emphasis was placed on an externally moderated reactor operating at a pressure of 500 psi, at a power level of 700 Mw(t), and capable of producing 1200 tons of CO per day. Programming of two computer codes for fuel cycle analysis was begun. PSYCHO is a fuel cost code while THORCYC is a multigroup diffusion theory code

for the fuel cycle analysis of fast breeder reactors operation on the Th–U^{233} cycle. Six stainless steel static capsules for the organic reactor coolant fouling studies were fabricated and the instrument and control panel completed. Reference runs with pure p-terphenyl are under way. Studies were conducted to check out the experimental procedures in the first bench contactor. The tilting frame and related parts of the tilting-furnace apparatus were completed and all auxiliaries connected. A method was developed for seal welding specimen tubes under gas pressures up to 200 psig. The axial-flow pump and surge vessel of the small circulating loop were completed and water tests started. A large gamma radiation source shield was modified for use with such a loop. Screening investigations of the radiolytic and pyrolytic stability of selected polyphenyls are continuing. (auth)

2461 (BNL-731(p.18-46)) CHEMISTRY AND CHEMICAL ENGINEERING DIVISION. O. E. Dwyer and R. H. Wiswall (Brookhaven National Lab., Upton, N. Y.).

The standard free energies of formation of $ThCl_4$ and UCl_3 were determined from cell measurements. The values at 500°C are −224.4 and −163.1 kcal, respectively. It was found possible to use anodic chronopotentiometry to measure the amount of subhalide that exists in fused salts containing $MgCl_2$ which were equilibrated with a Mg–Bi alloy. This technique is to be used in experiments designed to elucidate the nature of subhalide species. The ultraviolet absorption spectra of $CoCl_2$, NaI, and a new series of $PbCl_2$–KCl mixtures were measured over a wide temperature range. The conductance mechanism in ThF_4 and $ThCl_4$ was investigated by experiments involving the electrolysis of cells containing a number of separate sections of solid electrolyte, of which the weight change was followed. The conductivity was determined to be wholly anionic in both cases. Analysis of the radiolysis products of perfluoro normal heptane after exposure to $\approx 10^9$ rad of 1.5-Mev Van de Graaff electrons showed a wide spectrum of compounds. About 2.0 molecules of starting material were destroyed per 100 ev of energy absorbed. Extraction coefficients for various elements from treated simulated waste solutions into equal volumes of 0.2 M I_2 in nitrobenzene at 24.9° ± 0.1°C, were measured. Extraction coefficients for divalent process chemical and fission product cations are usually of the order of 10^{-3}, while those for trivalent cations are usually of the order 10^{-4}, compared with extraction coefficients for Cs of between 11 and 19. Type 347 SS was dissolved in a 309 SCb SS container, where the latter has been preferentially protected from corrosion. Corrosion studies of 309 SCb and 304L SS and Ni-o-nel in Zirflex solutions are continuing. The adsorption isotherm of I_2 on TSX reactor graphite at 800°C was measured at 2 to 30 mm Hg. In this range the reversible adsorption was independent of pressure and very small (10 ppm), amounting to less than 2% of a monolayer. However, residue I_2 compounds which could not be removed at 950°C were formed by contacting the graphite with saturated I_2 vapor at 25°C. This residue was 632 ppm after a 19-day exposure and is in excess of a monolayer. The surface area of the graphite determined with I_2 at 100°C agreed with the B.E.T. (N_2) area determined at liquid N_2 temperature. Preliminary measurements on the more rapid Kr^{85} apparatus are encouraging, but indicate that it is necessary to modify the counting equipment to correct for the variable Ar atmosphere. The small pilot plant for producing phosphate glass from various types of simulated high level waste was operated briefly. Bench-scale experiments showed that satisfactory appearing phosphate glasses could be made on a continuous basis at 1100°C from aluminum nitrate (Redox) wastes. Development of a rotary calciner for the treatment of high activity, Al wastes is now concerned with perfection of the equipment in preparation for a 1000-hr run. Particular emphasis is placed on the improvement of the rotary seal and the solution feeder nozzle. The longest run to date (over 50 hr) was successful. Satisfactory recovery of U from UC was obtained via the oxidation-fluorination route using the inert fluidized bed method. Several alundum-lined reaction tubes were fabricated for containing high temperature Cl_2. However, when one such tube was used for the chlorination of SS, cracks developed in the alundum liner. The alternate solvents, NOF·3.1 HF and N_2O_3–HF, for the Nitrofluor process compared favorably with the original solvent, N_2O_4–HF, in dissolution studies with several fuel element materials. Both alternate solvents are capable of dissolving Zr, Al, UO_2 ceramic fuel, and type 304 SS at satisfactory rates. Thus, their versatility approaches that of N_2O_4–HF, the essential difference being that they do not disintegrate graphite or graphite-matrix fuels. This oxidizing action is related to the existence of NO_2^+ (nitryl) ions and/or molecular HNO_3, neither of which exists in the alternate solvents. Pyrolytic graphite-coated UC_2 spheres and ZrC are also rapidly attacked by N_2O_4–HF. An improvement was made in volatilizing UF_6 from $NOUF_6$ by increasing the number of BrF_3 treatments. The nonvolatile U in a Zr salt residue was reduced to 94 ppm after six treatments at 150°C, giving a U recovery in excess of 99.8%. In a new volatilization reaction, the U in $NOUF_6$ salt was separated as a volatile compound by contacting the $NOUF_6$ with either gaseous NOF·3.1 HF or NOF rather than with BrF_3. The reactions were performed in a tube furnace at 500°C, and UF_4 was identified as one of the solids which condensed in a downstream zone at 390° to 400°C. Although the reactions are not yet understood, the method appears to have interesting possibilities. Thus, NOF·3.1 HF could serve initially as the fuel solvent and subsequently as the volatilizing agent. Significant progress was made in solving the corrosion problem associated with handling the three solvents in Ni or Monel equipment. In loop tests, corrosion rates as low as about 1 mil/month were achieved with certain combinations of solvent and container material for both Zr-matrix fuel and UO_2 ceramic fuel. The exposure involved initial fuel dissolution followed by alternate evaporation and condensation cycles during a one-week period. The results showed that Zr-matrix fuel was best handled in Ni equipment using NOF·3.1 HF as the solvent. The best combinations for UO_2 fuel were Ni with N_2O_4–HF and Monel with NOF·3.1 HF. If both types of fuel are to be handled in the same equipment, Ni would be preferred to Monel. Other Nitrofluor developments of interest include measurement of the electrical conductance of the NOF–HF system, determination of the gaseous products resulting from dissolution, and the application of infrared spectra in determining the approach to the azeotropic composition during NOF·3.1 HF production. In the study of the release of fission products from molten fuel elements the products were passed in a He stream through a uniform temperature gradient and a good separation of I^{131}, $(La–Ba)^{140}$, and Ce^{141} obtained. Iodine was found to be released in a chemically combined rather than in the elemental form. The direct reaction of Te and U was carried out and the unit cell of the product determined by x-ray diffraction. Initial runs on the diffusion of Te in Al were made at 600°C in the new accurately thermostated two-zone furnace, and a graph showing the fractional uptake is presented. In the study of fused salt-

liquid metal extraction columns, tracer breakthrough experiments have indicated that for mixing in the direction of flow of the continuous, salt phase of a disk-and-doughnut column, the Peclet number is ≈5. Preliminary results of mass transfer experiments in the same column agree qualitatively with the predictions of a model which was successfully used for aqueous-organic systems near room temperature. Developments in the liquid-metal heat transfer research program include startup of the alkali-metal loop. It will be used first to study heat transfer rates to NaK flowing in-line through unbaffled rod bundles. The first results, although in general agreement with predictions on the basis of earlier theoretical and experimental studies, showed certain anomalies. It is believed that bowing of the rods, as a result of binding at the bottom guide plate, is the major cause of the difficulty and remedial action is being taken. Another development involved the Hg loop. It was used to obtain data similar to that being taken on the NaK loop. Theoretical and experimental studies led to the conclusion that the heat transfer coefficient for liquid metals flowing through staggered rod bundles should remain at the stream-line value for Reynolds numbers up to about ten times that corresponding to the transition from streamline to turbulent flow. Data to support this conclusion were taken which showed that the experimental results were as predicted. (auth)

2462 (BNL-731(p.47-52)) RADIATION DIVISION. B. Manowitz (Brookhaven National Lab., Upton, N. Y.).

Studies are continuing on the effects of radiation in organic solids, the mechanism of radiation-induced vinyl polymerization, and the mechanism of radiolysis in aromatic compounds. An in-pile chemonuclear loop is being designed, in-pile capsule experiments are being carried out, chemonuclear fuel is under development, radiation chemistry experiments with isotopes are under way, and chemonuclear reactor process systems being investigated. The radiation polymerization of ethylene and the copolymerization of ethylene with formaldehyde, benzaldehyde and methyl methacrylate, was studied, along with the gamma radiolysis of anhydrous and aqueous ammonia and dicumene chrome. A design, feasibility, and hazards study for a facility to perform gamma radiolyses in circulating systems at high pressure was instituted. X-ray diffraction measurements of the thermal expansion coefficients under vacuum were made for ThO_2 to 2500°C and Re metal to 3000°C. In both instances no structural transitions were observed. Co^{60} sources were shipped to Costa Rica and Mexico City. Feasibility studies on a portable Co irradiator and a portable particle accelerator were instituted. Experimental work in the area of safety was continued with studies on the heat buildup in arrays of Co sources in air, and the effects of gamma radiation on the integrity of glass windows. Experimental determination of dose distribution in cylindrical targets surrounding cylindrical sources was initiated, in addition to an investigation of the effect of surrounding reflecting walls on dose distribution. The development of an n-on-p Si solar cell as a high-level dosimeter (dose rate and integrated dose measurements) continues. (auth)

2463 (BNL-731(p.53-8)) HOT LABORATORY DIVISION. L. G. Stang, Jr. (Brookhaven National Lab., Upton, N. Y.).

Although an intensive study of the problem of iodination of protein by I^{124} has thus far failed to provide reasons for previously poor yields, it showed that the iodination yield is affected by the presence of traces of Sb or of Cl_2, the concentration of ICl, and the mole fraction $[ICl]/([ICl] + [I^-])$. The half-life of hitherto undiscovered Sn^{129} was found to be about 3.5 min; new gammas and revised beta energies were found for Sn^{128} and Sb^{128m}, and the half-life of Sn^{130} was revised. The new 170-kev gamma of Sc^{48} was shown to be in coincidence with each of the 1.0-Mev gammas, with the 1.3-Mev gamma, and with a new softer (ca. 480-kev) beta, but not with the harder (ca. 650-kev) beta. The thick target cross section for the $Mg^{26}(t,p)Mg^{28}$ reaction for 2.7-Mev tritons was found to be 8 mb. A new technique using the IBM 7090 computer which permits simultaneous determination of counter resolving time, sample half-life, and sample initial activity was used to measure the half-lives Al^{28}, 2.28 ± 0.01 m and F^{18}, 109.9 ± 0.2 m. The search for gammas in coincidence with backscatter radiation is useful in deciding, in the case of unraveling a complex decay scheme, whether or not in addition to coincident gammas another gamma is present which is not in coincidence with the others; it is also a useful technique for the determination of positron-emitting impurities in a beta-gamma-emitting matrix. A very satisfactory Al^{28} generator which yields a 99.999% pure product in 30 sec and which can be milked dozens of times per hour for several days was developed. The reactor-induced (n,2n) reaction is not a suitable one for the production of "Ca^{45}-free" Ca^{47}. Research and development work in the area of radiochemical analysis includes the following items of note. Tri-n-octylamine was found to enhance enormously the extraction of U by 2-thenoyltrifluoroacetone, and two postulated equations explaining this phenomenon were tentatively verified. A study of the mechanism of dissolution of Zr in LiCl−KCl eutectic was begun. Previously reported discrepancies in the abundances of gammas from $Te^{129m, 129}$ have been confirmed, and the decay scheme is under investigation. The new mass spectrometer was put into relatively satisfactory operation. γ-γ coincidence counting has been used to confirm the simultaneous presence of Co^{60} and Fe^{59} in diamond dust. An x-ray fluorescence technique and a spectrophotometric technique were used to determine traces of P. In the area of isotope production, increases in demand for Y^{90} beads, Y^{90} generators, Tc^{99m}, Mo^{99}, and K^{43} were noted. The net change in "D" waste inventory was an increase of only about 5,000 gal, owing primarily to repainting of the shallow end of the reactor canal, an operation which is now completed. (auth)

2464 (BNL-731(p.59-94)) METALLURGY DIVISION. D. H. Gurinsky (Brookhaven National Lab., Upton, N. Y.).

The presence of Zr and Ti at the cold point in an all-liquid Hg loop reduces corrosion of the carbon steel; Zr reduces it more than Ti. Zr additions are also more effective than Ti additions in reducing over-all corrosion in carbon steel-boiling Hg loops. 2¼ Cr−1 Mo steel may be as good or better than carbon steel in resisting attack by boiling Hg containing Ti; Ti addition apparently eliminated boiler corrosion of Haynes alloy #25 by boiling Hg. The most severe attack in a boiling system is in the condensing area. The presence of Zr in the Hg apparently reduced this corrosion also. The "protective film" observed on carbon steel tabs contacted with Hg + Ti or Zr could not be identified by x-ray or electron-reflection diffraction. Fabrication of the first high-velocity boiling Hg loop was completed. Liquid Hg pumps were selected and design of pumped loops initiated. A cold-trap + hot-trap purifier for Na is being tested. No radiographically-detectable corrosion was detected on Nb, Ta, and Mo by boiling Na in Nb−1 Zr reflux capsules at 2200°F boiling temperature. Fabrication of two Nb−1 Zr Na thermal convection loops and one boiling Na loop was started. A second series of fuel ele-

ment tests for HFBR was designed and is being fabricated. One coupon of 30 wt % Dy_2O_3 in SS was irradiated 3 cycles in MTR without visible damage. Sample welds made in 6061 T-4 Al plate 2 in. thick were made to compare C-809 and 4043 filler metals. Tensile tests showed these welds to have well above the required strength, and the C-809 weld to be slightly stronger. Mechanical and joining properties of B_4C–Al dispersions were studied. Studies of the emf of W–Bi and Fe–Bi thermocouples showed that the dissolved Fe does not affect the absolute emf of liquid Bi; the potential of the Fe–Bi electrode is sluggish in obtaining equilibrium. Significant currents can be drawn from carbon steel–liquid Bi–5 Cr–½ Mo steel cell for indefinite periods of time without polarization. Under electrolysis, Ag and Fe migrate against the electron flow through liquid Bi. Quantitative data on Ag migration are being obtained. Cr migrates with the electron flow; quantitative determinations may be possible in this system. Fe segregation during solidification appears to make quantitative measurements on Fe–Bi migration impossible with the present apparatus. Methods of measuring the solution rates of solid metals into liquid metals that will permit separation of the surface reaction and liquid diffusion steps are being surveyed. Liquidus curves of Be, Nb, Os, and Ir with liquid Bi were further investigated. Data were obtained on Be and Nb. Liquidus curves of Fe, Nb, Cr, Ti, and Zr with Hg were investigated; Nb was not detected (<0.1 ppm) in the melts. Sharp tracks were observed in a thin film of Li^6F after pile irradiation, probably produced by the energetic τ and α particles produced by the n-α, τ reaction on Li^6. The energy is not sufficient to vaporize the atoms in the track, but is great enough to produce a fused track. Post-irradiation testing of as-received pure Fe was completed for exposure levels up to 10^{19} nvt. After a certain exposure, the yield stresses become independent of grain size; the plastic behavior then resembles that of pre-strained Fe. Post-irradiation annealing at 350°C removes the embrittling effect of radiation, but leaves some of the increase in yield stress. Techniques for thinning specimens of annealed pure Fe foil have been perfected to yield a specimen free from dislocations as observed in the electron microscope. Kinetic equations were derived that yield values for the behavior of graphite under irradiation in good agreement with the observed behavior. Both single (C) and double (C_2) interstitials are produced; the single interstitials exist in steady-state concentration only during the irradiation, and are unstable; the observed growth and annealing phenomena result from the production and subsequent behavior of the C_2 interstitial species. The total physical expansion of graphite during irradiation can be recovered by annealing after short irradiation intervals. Hi-flux graphite irradiations in ETR were planned. Studies of the rate of bromination of graphite and the exchanges of radio-Br with brominated graphite are being pursued to evaluate the role interstitial atoms, such as Br, play on the physical (especially the electrical) properties of graphite. The rate-controlling process appears to be neither a diffusion nor a surface reaction. The rate of bromination is slower than the rate of exchange. The electrical properties (Hall coefficient and resistivity) of graphite are affected by irradiation; annealing reduces the damage. The reduction does not correspond to changes in the dimensional properties. Release of fission gases from irradiated UC and UC_2 powders below 850°C is much higher than would be extrapolated from high temperature data (which show a large activation energy), but is restricted to regions very close to the surface. Micro examination of the Hg loops showed the mass-transferred deposits in the Haynes alloy #25 loop boiler to be tenacious, and to be ≈70% Co and 30% Cr. A loose deposit in the boiler and a condenser deposit were principally Ni. (auth)

2465 (BNL-731(p.95-7)) ENGINEERING DIVISION. T. V. Sheehan (Brookhaven National Lab., Upton, N. Y.).

Erection of the steel shell for the High Flux Beam Reactor building is now under way. Rather than make changes in the shielding for the HFBR Critical Assembly this facility will be moved to the new Critical Assembly building. Construction work on the NaK Heat Transfer Loop is now complete. Design, construction, and test work is continuing on various other loops for chemonuclear, heat transfer, and corrosion studies. The cryostat for the Slow Neutron Chopper was completed. All changes to the Low Mass Critical Assembly were also completed. A fuel rod shipping cask for the UO_2–ThO_2 Lattice Experiment is being designed. The Engineering Division is continuing to assist with the evaluation of proposals for the High Intensity Radiation Development Laboratory. The MIT and University of California irradiators are operating full time with no malfunctioning reported. The installation of Co^{60} sources for the University of Washington was postponed. A test batch of SRP type Co sources is being encapsulated to confirm with SRP specifications. A shielded cask for the Graphite Oxidation Study high temperature furnace is being designed. Work is continuing on the development of a seal for the Rotary Calciner. Preliminary design of the Settled Bed In-pile Capsule is now complete. The construction of the Dissolver Pilot Plant was also completed this period. (auth)

2466 (BNL-6309) SOME METHODS FOR IMPROVING THE CYLINDRICAL REFLECTING BOUNDARY CONDITION IN CELL CALCULATIONS OF THE THERMAL NEUTRON FLUX. H. C. Honeck (Brookhaven National Lab., Upton, N. Y.). [1961]. Contract [AT(30-2)-Gen-16]. 8p.

Various methods are examined,and data obtained using a cell consisting of an 0.25-in.-diam. 1.0% enriched U rod clad with 0.030-in. Al in a triangular water lattice are presented. These results indicate that quantities which are of importance in describing the thermal neutron flux in the cell are adequately predicted by adding either a scattering region or homogeneous region (with consistent δ) outside the cell, although the scattering region appears preferable in both speed and accuracy. (J.R.D.)

2467 (BNL-6310) SOME CONTROL PROPERTIES OF REFLECTOR MODERATED REACTORS. Paul Michael (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract [AT(30-2)-Gen-16]. 5p.

Control characteristics of research reactors in which most of the neutrons are thermalized in the reflector before returning to the core are examined. It is noted that such reactors often have control properties which are very different from those found in the usual thermal reactor, and it is shown that great care must be used in design. (J.R.D.)

2468 (CRRP-985-E) NEUTRON RETHERMALIZATION IN METALS. B. G. Chidley, C. B. Bigham, and R. B. Turner (Atomic Energy of Canada Ltd., Chalk River, Ont.). Aug. 1962. 46p. (AECL-1601)

Relative reaction rates of Mn^{55}, Lu^{176}, and In^{115} were measured through the central lattice cell of ZEEP with the fuel cluster replaced by a pressure tube containing Mg, Al, Fe, Zircaloy, or Pb. Measurements were made with the test section at room temperature and at 280°C. The radial

variations are given for the reaction rates, which were measured, and for the effective neutron temperature T_n, and the epithermal index $r\sqrt{T_n/T_0}$, as deduced from the reaction rates. Rethermalization cross sections for a two temperature group model were derived. The values obtained are larger than those predicted by the free gas model. Earlier results were analyzed to obtain rethermalization cross sections for H_2O and D_2O. (auth)

2469 (DL-52) AN ASSESSMENT OF PLUTONIUM USE. W. Bennett Lewis and O. J. C. Runnalls (Atomic Energy of Canada Ltd., Chalk River, Ont.). Sept. 1962. 18p. (AECL-1608)

Data and information concerning the use of Pu are presented. Comparisons are made which are based on the relative cost of natural U and of processing and fuel fabrication with enriched fuel. It is noted that the largest use of Pu for sometime to come will be as a fissile material in situ with U^{238}. (J.R.D.)

2470 (EIR-28) SUBCRITICAL REACTOR KINETICS AND REACTIVITY MEASUREMENTS (thesis). Tsahi Gozani (Switzerland. Eidgenossisches Institut für Reaktorforschung, Würenlingen). Sept. 1962. 128p.

Three kinetic (source-jerk, rod-drop, and pulsed source) methods of measuring reactivity in the subcritical state are discussed from both the theoretical and experimental points of view. The kinetic, static, and dynamic role played by the three reactivities is demonstrated by the general transport theory. After reducing this to the multigroup model, additional important properties of delayed and prompt neutron distributions are shown. Using two group time dependent theory, numerical examples are given to show the importance of these properties in heavy water reactors. With the help of the theoretical results, modification of the source-jerk and rod-drop techniques, aimed at lessening perturbing effects, are discussed. These modified experimental methods were successfully checked in the swimming-pool reactor SAPHIR and the heavy-water reactor DIORIT in Würenlingen. Some of the experiments are reported. (auth)

2471 (GAMD-2676) AN ANALYSIS TO DETERMINE THE PERCENTAGE OF HELIUM BYPASSING THE CORE DUE TO THE REFLECTOR SEALING SYSTEM DURING NORMAL OPERATION OF THE HTGR. F. B. Nimtz (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nov. 15, 1961. Contract AT(04-3)-314. 25p.

The percentage of helium which will bypass the core if the reflector system shown is used is predicted. It is estimated that nominally about 0.1 to 0.2% of the total flow will bypass the core, which is not considered excessive. The most difficult parameter to determine was Z, the gap between the sealing surfaces. The method used to predict Z is presented. The effect of bowing due to a temperature gradient across the seals is discussed. (auth)

2472 (GNEC-251) DEVELOPMENT OF HYDRAULIC BALL (HY-BALL) CONTROL SYSTEM. Progress Report No. 1, July–September 1962. S. J. Weems, S. E. Turner, and R. W. Taylor, Jr. (General Nuclear Engineering Corp., Dunedin, Fla.). Oct. 2, 1962. Contract AT(39-1)-207. 81p. (EURAEC-456)

Reactor fuel cell parameter studies were initiated to indicate the dia. of the Hy-Ball control columns which show the most promise. These studies are based on a 974-Mw(t) boiling water reactor for a 300-Mw(e) plant; the fuel configuration (typical of present day technology) consists of rods made up of UO_2 pellets clad with 0.520 in. OD by 0.025 in. wall zircaloy-2. The largest size Hy-Ball column (as limited by water-hole peaking) under consideration contains 1⅜ in. dia. balls operating in a 1 7/16 in. ID tube. The smallest size column (replaces a single fuel element in a uniform array) contains ½ in. dia. balls operating in a 9/16 in. ID tube. Of these two sizes, it was tentatively concluded that the smaller ball column (½ in.) is preferred because of the reduction in control system capacity, the higher control worth per unit of core volume, greater design flexibility, and lower water-hole flux peaking. The water-hole peaking factor of the 9/16 in. ID Hy-Ball column is approximately 1.025. Calculations of the approximate equilibrium unrodded, unflattened core for a three-radial zone out-in fuel shuffling program indicate a radial maximum-to-average power ratio of about 1.2 and an axial peaking factor of about 2.5. Partial core length Hy-Ball columns and/or burnable poison will be considered for reduction of the axial peaking factor. A cold water test loop (air-water, 80°F, 150 psig) was constructed and operational tests were begun on a 1½ in. ID transparent plastic simulated Hy-Ball column using balls ranging in dia. from 1 5/16 in. to 1 7/16 in. and using solid cylinders having a dia. of 1 7/16 in. Scram time-displacement information and lifting flow rates were obtained. The simulated reactor Hy-Ball column system is pressurized with air to effect fast scrams by forcing the water within the column downward and out through the control line. Scrams of 10 ft ball stacks were achieved in less than 1 sec by using a high driving pressure. A reference design of a hot test loop for operation at 1250 psia, 572°F was established. Specifications were prepared, and requests for bids on the expected long lead items (the recirculation pump and autoclaves) were submitted to vendors. The hot test loop will consist of two 6 in. ID by 20 ft autoclaves (simulating reactor vessels) together with the necessary pump, piping and valves for operation of Hy-Ball columns. An extra leg of the recirculation loop is provided for the separate testing of additional remote controlled valves. (auth)

2473 (HW-66804(Rev.)) REPORT ON CHEMICAL DESCALING OF 105 REACTOR HIGH TANK PIPING. H. F. Jensen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 21, 1960. Contract AT(45-1)-1350. 15p.

A method was developed to re-circulate a 10% solution of H_2SO_4 through the high-tank discharge piping. The acid was heated to 40 to 50°C and pumped into the high-tank discharge line at the drains in the valve pits. Pumping at a rate of 200 gpm to each of the two high-tank discharge pipelines, the acid solution backflushed the discharge line overflowing at the high-tank mudlegs. A suction pump siphoned the acid from the mudlegs, returning it to the make-up holding tank. An average of six hours of recirculating the acid solution was required to obtain the desired removal of scale and barnacles in the piping. Drawdown tests following completion of the descaling work indicated flow increases of approximately 25% at B, D, and F reactors and approximately 10% at H reactor. The lower percentage flow increase at H reactor was due to its larger diameter piping, which compared to the smaller piping at the other reactors showed a smaller relative gain even though the same proportion of scale was removed. The flow improvements were short of the theoretical values since the surface of the cleaned pipe was rough and pitted. (auth)

2474 (HW-SA-2711) A SURVEY OF THE ECONOMICS OF PLUTONIUM AS A FUEL IN THERMAL REACTORS. E. A. Eschbach (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 4, 1962. Contract AT(45-1)-1350. 53p.

Studies were made of the utilization of plutonium in thermal reactors. Results indicated that the value of plutonium for these reactors is greater than earlier studies predicted. In addition, several special applications of plutonium were identified. Reactor physics and economics codes were developed that are sufficiently rapid to enable survey of the possible systems and still be sufficiently accurate to take into account the pertinent factors as to direction and relative magnitude. Two major fuel management schemes were examined: batch and graded loading. It appeared that incremental fabrication charges associated with plutonium toxicity will not greatly reduce plutonium values because the reactor fuel loadings can be designed either to concentrate all of the plutonium in a part of the fuel elements or to employ a large total amount of plutonium throughout the reactor. Results are presented in graphs and tables. (M.C.G.)

2475 (KR-27) A PARAMETRIC STUDY OF BURN-UP PERFORMED ON AN ANALOGUE COMPUTER. R. J. J. Stamm'ler and W. A. Raaymakers (Norway. Institutt for Atomenergi, Kjeller). July 1962. 38p.

A study was made of the influence of variations in the parameters which govern the burn-up equations for a batch irradiated single fuel load. The equations are presented and the parameters for a special reference reactor are given. Results obtained on an analog computer are given. All parameters but the enrichment were varied separately, and in each case an initial excess reactivity of 10% was available for burn-up. Tables of some of the results are included. The influence of changes of the enrichment was examined. Therefore, two special reactors were considered: one to cover the enrichments from 0.72% up to 1.00%, and the other for the range from 1.50% to 2.00% enrichment. A table giving some results of these variations of enrichment is included. Graphs are also presented. (auth)

2476 (NAA-SR-5993) TECHNICAL DESCRIPTION OF A SODIUM-COMPONENT TEST INSTALLATION. (Atomic International. Div. of North American Aviation Inc., Canoga Park, Calif.). Jan. 4, 1961. Contract AT(11-1)-Gen-8. 96p.

The installation is designed primarily for operational testing of Na-heated steam generators and intermediate heat exchangers suitable as prototype components for large, Na-cooled power plants. Other types of Na components can also be tested in the facility. The installation consists of a 35-Mwt gas-fired Na heat source, a main primary-Na system, a main secondary-Na system, a water-steam system, and a set-up for heat rejection to air. (J.R.D.)

2477 (NP-12187) ANALOG COMPUTER SIMULATION OF CONDENSER AND FEEDWATER HEATER TRANSIENTS, SM-2 (APPR-1B). J. O. Brondel (Alco Products, Inc., Schenectady, N. Y.). Feb. 24, 1959. 32p. (AP-Note-129)

The thermal transient behavior of surface condensers and feedwater heaters was analyzed. Differential equations of temperature behavior are defined which permit convenient simulation by analog computer circuitry with a minimum sacrifice in true representation. Typical constants for the SM-2 (APPR-1B) condenser were employed to derive a scaled analog circuit. The transient response of this circuit to steam flow perturbations is illustrated. The emphasis of these simulations is more on fidelity than on reduction in number of computer components necessary. The process of reducing simulation detail is more easily accomplished in achieving a practical compromise. (auth)

2478 (TID-16995) SODIUM COMPONENTS DESIGN PROGRAM. Progress Report. (Baldwin-Lima-Hamilton Corp., Eddystone, Penna.). Sept. 28, 1962. Contract AT(11-1)-1213. 9p.

Activities in a program to develop and construct a steam generator and test loop for use with a 30-Mw sodium reactor are reported. Details of conferences held for the benefit of personnel interested in the Na components design program are given, and progress on fabrication of the steam generator is summarized. (J.R.D.)

2479 (TID-17032) A STUDY OF CHEMICAL POISONS FOR NUCLEAR REACTOR CONTROL. Technical Memorandum No. 25. Robert Vincent Batch (Argonne National Lab., Ill.). June 1961. Contract W-31-109-eng-38. 63p.

The requirements for a nuclear control system and factors for comparing chemical and mechanical control systems are discussed. A comparison is presented of coolant and auxiliary chemical control systems. Methods of control are described. Nuclear, chemical, engineering, and economic considerations for chemical poisons for nuclear control systems are outlined. Studies were made of lithium, cadmium, and rare earth salts and boric acid solutions. Of all the poisons tested, boric acid showed the greatest stability combined with the least corrosion of all materials tested. Methods of reactor poison concentration control are described. The feasibility of chemical control systems is discussed. The development problems related to chemical control are listed. (M.C.G.)

2480 (TID-17050) TEMPERATURE DISTRIBUTION AND VAPORIZATION RATES IN A SUPERHEATED LIQUID JET. Nuclear Reactor Containment Bimonthly Report No. 14. George R. Gavalas (Minnesota. Univ., Minneapolis). Sept. 1962. Contract AT(11-1)-926. 13p.

Studies in nuclear reactor containment involve the evaluation of the rates of energy release from breaks in the reactor system. One such problem involves the mass rate of flow of water from an aperture. The problem considered is the outflow of a super-heated liquid in the form of a jet and an estimation of the rate of vaporization from the surface of the jet. Idealized models are considered. A program to estimate the mass and energy transfer from a jet to the surrounding gas is reported. Vaporization from the surface of the jet will cool this surface and the assumption is made that the rate of heat transfer by conduction in the field jet is the limiting process. No mixing within the jet is considered. For a jet in contact with its vapor, the highest heat conduction rates are obtained for the surface of the jet at the temperature of the vapor. The results of the analyses for the idealized models indicate that even with high superheats, the fraction of the initial jet that is vaporized is relatively small. (auth)

2481 (TID-17195) MAJOR ACCIDENT STUDIES FOR ZERO-POWER EXPERIMENTAL FAST REACTORS. Sushil Kapil and George J. Fischer (Argonne National Lab., Ill.). July 1962. Contract W-31-109-eng-38. 5p. (UAC-6706)

The results of computer calculations concerned with the behavior of zero power experimental fast reactors such as ZPR-III or ZEBRA are summarized briefly for several very different core loadings in order to learn the relative hazards of these loadings and to provide a guide to the safe operation of the reactors. The analysis was performed by the AX-I code which calculates the neutronic, thermodynamic, and kinetic behavior of the reactor as a function of time over the course of the burst. (N.W.R.)

2482 (CEA-tr-A-1057) CALCUL DE LA CIRCULATION DANS UN RÉACTEUR À EAU BOUILLANTE.

PARTE II. (Calculation of Circulation in a Boiling Water Reactor. Part II). W. Balz and R. Schwarzwaelder. Translated into French by Z. Horusitzky from Atomkernenergie, 5: 1-6(1960). 24p.

The most important works on the subject of pressure drop in a two-phase mixture are described with the purpose of determining its possible application to the study of the operation of a BWR. The possibilities for representation of the pressure drop are illustrated with several examples. (tr-auth)

2483 NEW AUTOMATIC CONTROL AND SAFETY SYSTEM FOR THE VVR-S REACTOR. Pavel Kovanic, Jaroslav Rygl, Karel Wagner, and Josef Teska (Inst. for Nuclear Research, Czechoslovak Academy of Sciences and V. I. Lenin Plant, Pilsen, Czechoslovakia). At. Energ. (USSR), 13: 350-9(Oct. 1962). (In Russian)

A previously described automatic control system (P. Kovanic et al., Atomnaya Energiya, 5: 403 (1958) No. 4) involving mobile detectors was installed in the Czechoslovakian VVR-S reactor. The detectors were placed in the channels previously used for the ionization chambers. The system may take over complete or partial control of the reactor's operation. The sensors used serve both as measuring and warning devices; a self-verifying device indicates the readiness of the control system to take the power level from subcritical state to the desired point, maintaining or changing the power as instructed. In case of malfunction, an energency warning alarm is sounded and preventive steps are taken to isolate the inoperative portions and transfer their functions to other components. Three sensing systems are used with mobile fission pulse chambers, encompassing the whole power level of the reactor. The system is also employed to control the negative period $T_e = -80$ sec. The rate of reactivity change could be increased during the first phase of the startup to 2.8×10^{-4} sec^{-1}. The system proved its worth during actual reactor operational runs; the few remaining technical difficulties can be easily remedied. (TTT)

2484 RELATIONSHIP BETWEEN BURNUP OF U^{235}, THE MWD VALUE, AND THE TEMPERATURE. F. Janitschek. Atomkernenergie, 7: 258-67(July–Aug. 1962). (In German)

The longer U is used as a nuclear fuel in a reactor the more the various by-products formed by the process influence the burn-up value (Mwd figure), in particular the isotopes of plutonium. This particle is a contribution for a more exact comprehension of the associations between the consumption of uranium, the burn-up, and the temperature. The selection of the basic data dependent upon the temperature and the discussion of various simplified methods have found a wide scope because the accuracy and difficulty of the calculation depend on them. Only the reactor type working with moderators and with natural or slightly enriched uranium and in which a vast amount of fission is caused by so-called thermal neutrons which possess the velocity of heat movement is considered. (auth)

2485 METHOD FOR THE SEPARATE DETERMINATION OF U^{235} AND Pu^{239} CONSUMED IN REACTOR FUEL ELEMENTS BY FISSION WITH THERMAL NEUTRONS. W. Schimmel. German Patent DWP 20009. Oct. 27, 1960. Kernenergie, 5: 583(July 1962). (In German)

A determination between two given fission isotopes can be made by a measurement of the intensity of the specific γ radiation of the isotopes under the assumption of numerous variations in the fission product yield. In order to obtain additional fission product data, further burn-up data were taken on the fast fission of U^{238} and Pu^{241}. The method has the advantage that not only the total values are determined, but that very accurate results are obtainable. (J.S.R.)

2486 METHODS FOR CONTROL OF REACTORS. W. Schimmel. German Patent DWP 20720. Feb. 3, 1961. Kernenergie, 5: 584(July 1962). (In German)

Methods for the control of reactors, especially power reactors, in which fission and corrosion products were continuously removed by the by-pass method and in which burn-up measurements were made with respect to the γ spectra of the fission products, were improved, so that better utilization of new fuel elements is obtained. According to the method outlined, the fission products, especially the γ energy of ruthenium and its decay products, of non-solid flowing fuel–fuel element slurry–were measured. According to the measurement results, burned fuel is removed from one side of the reactor and new fuel is introduced. (J.S.R.)

2487 METHOD FOR THE OPERATION OF A REACTOR AS WELL AS A REACTOR FOR CARRYING OUT THE METHOD. G. Helmis. German Patent DWP 20899. Feb. 15, 1961. Kernenergie, 5: 583(July 1962). (In German)

Reactors with non-solid flowing fuel can be improved if the fuel removed from the fission zone is used in the space surrounding the fission zone. Moderator, coolant, and absorber are present also in accordance with the operating conditions. The arrangement in the space acts as reflector and affects both the power distribution and the spectrum within the fission zone proper and works as a shield. (J.S.R.)

2488 NUCLEAR REACTORS. W. Schimmel. German Patent DWP 21004. Mar. 7, 1961. Kernenergie, 5: 584 (July 1962). (In German)

Reactors, especially high-power reactors, were improved and simplified if the channels of the flowing media (fuel slurry or coolant) lies at a slope, that is pipes, inclined plates, or traps. The inclination is changeable in dependence on one or several operational magnitudes of the reactor installation–if necessary automatic. Steps or the like can be present in the fuel channel. Site and placement of the steps can be arranged in various ways. It is recommended that the gradient of the fuel channels be such that the poisons formed, especially gaseous poisons such as xenon, can be periodically or continuously carried off. (J.S.R.)

2489 REACTORS, ESPECIALLY PRESSURIZED OR BOILING WATER REACTORS. H. Spindler, H. Arndt, and W. Schimmel. German Patent DWP 21219. May 31, 1961. Kernenergie, 5: 584(July 1962). (In German)

In reactors, especially pressurized or boiling water reactors in which part of the cassettes and/or fuel elements, especially their cladding, supports, lattice spacers, and cassette tops and bottoms, within the fission zone consists of sintered materials, an improvement and price reduction could be obtained if the core material is so highly pressed that the highest possible density is obtained. One of the components is a metal or a metal alloy with large neutron absorption capacity, whereas at least one of the other components consists of a metal oxide. (J.S.R.)

2490 REACTORS, ESPECIALLY HETEROGENEOUS POWER REACTORS. H. Spillmann. German Patent DWP 21268. May 23, 1961. Kernenergie, 5: 584(July 1962). (In German)

In reactors, difficulties occur as a result of irregular fuel burn-up. The necessity therefore arises of replacing fuel elements or a portion of them with new fuel elements. Apparatus necessary for fuel rotation is costly and space

consuming. Reactors cooled by a flowing medium can be improved if the fission zone consists of at least two partial zones, each being able to rotate. In this way the fuel elements can be moved automatically through the area of strongest neutron flux. The fission zone can consist of an odd number of partial zones. With several partial zones, one partial zone can be placed in the center, whereas the usual form is a ring. (J.S.R.)

2491 DEVICE FOR THE RELOADING OF CASSETTES IN REACTORS. H. Spillmann. German Patent DWP 21291. May 23, 1961. Kernenergie, 5: 584(July 1962). (In German)

Devices of this type, especially for heterogeneous power reactors, consisting of a gripping apparatus extending into the reactor were simplified and improved with a carrier arranged centrally in the reactor. The gripping apparatus moves in an axial direction on the carrier and can rotate with the carrier. The carrier can be constructed of tubes and can be arranged to rotate in the deck of the reactor vessel. (J.S.R.)

2492 CASSETTE ARRANGEMENT FOR HETEROGENEOUS POWER REACTORS WITH THE CASSETTE CONTAINING THE FUEL ELEMENTS. H. Spillmann. German Patent DWP 21374. June 21, 1961. Kernenergie, 5: 584 (July 1962). (In German)

A new cassette arrangement for heterogeneous power reactors was proposed with the purpose of obtaining an improved and more controlled burn-up of the fuel elements. The arrangement is so set-up that the cassettes have a rectangular or sphenoid cross section and are introduced in corner sectors of the fission zone from the outside to the inside from a tangential bearing to a radial bearing. The sector points are therefore arranged radially in the fission zone. The sectors form one or more almost closed cassette rings entirely penetrated by coolant channels. (J.S.R.)

2493 REACTOR INSTALLATION WITH PRIMARY AND SECONDARY CIRCUIT FOR LIQUID, GASEOUS, ATOMIC, OR MOLECULAR MEDIA. H. Schelle, H. Arndt, and O. Heise. German Patent DWP 21515. July 5, 1961. Kernenergie, 5: 583(July 1962). (In German)

The purpose of the present invention is to save on site size and material in reactor installations. This is attained by building the reactor in such a way that a number of heat exchanging elements will serve as primary circuit, which on one side project into the reactor fission zone. On the other side a container is introduced which forms at least a part of the secondary circuit. The heat-exchanging element can serve at the same time as moderator. (J.S.R.)

2494 DEVICE FOR THE TRANSPORT OF FUEL ELEMENT CASSETTES IN HETEROGENEOUS REACTORS. H. Spillmann. German Patent DWP 21532. July 14, 1961. Kernenergie, 5: 584(July 1962). (In German)

Transport mechanisms for fuel element cassettes can be improved and simplified if pressure cylinders operating with a gaseous or liquid medium are provided with a feed of movable suspended ordered cassettes of long length indirectly coupled at the cassette end. Piston rods acting on the cassette end are coupled by a parallel drive or pull rod so that the piston travels identical paths in spite of opposing forces. One of the pistons is solidly connected with the drive rods, whereas the other has a slipping connection and is therefore detachable or disengageable. (J.S.R.)

2495 A SERIES OF COMPUTER PROGRAMS FOR THE SOLUTION OF REACTOR KINETIC AND REACTOR DYNAMIC PROBLEMS WITH THE HELP OF REPEATING INTEGRALS. J. Patry (Eidg. Institut für Reaktorforschung, Würenlingen, Switzerland). Neue Tech., 4: 383-94(Aug. 1962). (In German)

Five programs for middle size computers (more than 4000 memories) and middle speed (more than 20 operations per second) are described in their principles and flow-chart. They are used to solve the problems of reactor kinetics and reactor dynamics. The first two programs, AGAMA and GFUNK, give an analytical and a numerical representation of the Green function and of the two first integrals from the dates on the delay neutrons and as a function of the generation time and the reactivity. The program DYNAU is based on the two main programs and solves the problems of reactor kinetics without taking into account the influence of power of reactivity. The last is defined by a subroutine which can be chosen completely free. The program DYNAV solves the same problem, but takes into account a linear feed back from the power on the reactivity. The dynamics program DYNAM is a simplified version of DYNAV, in which the reactivity is defined by segments of linear functions. The great advantage of these programs is the high precision which can be obtained with them. (auth)

2496 THE MEASUREMENT OF DYNAMIC NUCLEAR REACTOR PARAMETERS USING THE VARIANCE OF THE NUMBER OF NEUTRONS DETECTED. Robert W. Albrecht (Univ. of Washington, D. C.). Nucl. Sci. Eng., 14: 153-8 (Oct. 1962).

A mathematical model is developed for the ratio of the variance to the mean number of neutrons detected in a point, unloaded reactor as a function of counting time. The model includes the effect of delayed neutrons. An experiment is performed which measured this statistic for counting times between one millisecond and ten seconds. The predictions of the model and the results of the experiment are compared. It is shown that a reduced two-delay group model predicts the experimental results fairly well. (auth)

2497 XENON SPATIAL OSCILLATIONS. D. Randall and D. S. St. John (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucl. Sci. Eng., 14: 204-6(Oct. 1962). (TID-15344)

Calculation results are given which show the effect of nonzero power coefficients on the xenon axial oscillation threshold flux. Threshold values are also given for flux tilt oscillations in a cylindrical reactor with a flattened radial power distribution. The calculations were performed on the basis of the material buckling required to excite the first harmonic. The oscillation period at the threshold is shown as a function of the threshold flux level. (auth)

2498 KINETIC BEHAVIOUR OF NUCLEAR REACTORS. J. Lewins. Nuclear Energy, 378-84(Oct. 1962).

Nuclear reactors are described in terms of their physical behavior in various regimes of complexity, corresponding to increasing power. The persisting distribution is given special attention since it is the consequence of the tendency of reactors to behave as a single entity. It is pointed out that in the most general case there is no unique characteristic of a system which can be considered independent of the detectors introduced into the system to measure the observable behavior. The equations for the reactor behavior are cast rigorously into the form of the well-known kinetic equations by relating them to the observed reactor behavior. Several different distributions of detectors can be employed for this measurement and the corresponding kinetics parameters such as reactivity and lifetime have different values depending on the distribution selected. After outlining the useful properties of the different distributions, a series of numerical values are given for three important reactor systems to illustrate the effects that are to be treated in current reactor practice. (auth)

2499 TWO GROUP REACTOR KINETICS. A. Foderaro (Pennsylvania State Univ., University Park) and H. L. Garabedian. Nuclear Sci. and Eng., 14: 22-9(Sept. 1962).

A study is made of the kinetics equations associated with two group reactor theory. The method involves expansions of each of the fluxes in an infinite series, each term of which is a product of a space-dependent eigenfunction and a time-dependent factor. Techniques are provided for the rigorous determination of transient flux shapes as well as the eventual stable or asymptotic flux shapes. (auth)

2500 IN-PILE PHOTOGRAPHIC STUDIES OF EBR-II MARK-I AND FERMI CORE—A SAMPLE MELTDOWN. C. E. Dickerman, G. H. Golden, and L. E. Robinson (Argonne National Lab., Ill.). Nuclear Sci. and Eng., 14: 30-6 (Sept. 1962).

Fast reactor fuel sample meltdown experiments were performed, in the TREAT reactor, with high speed color photography. EBR-II Mark-I and half-length Enrico Fermi Core-A type elements were studied. In addition, preliminary experiments were performed on EBR-II size UO_2 samples. Sample conditions at the times of failures, types of failures, and rates of emission of material from the elements were obtained. Course of failure following the initial emission of material is obscured, in the EBR-II sample case, by release of "clouds" of sodium originally present inside the element to effect a thermal bond between fuel and cladding. Photographic results were found to be consistent with previous deductions on sample failures obtained from opaque meltdown experiments. (auth)

2501 DESIGN AND ANALYSIS OF THE EXPERIMENTAL GAS-COOLED REACTOR FUEL ASSEMBLIES. G. Samuels (Oak Ridge National Lab., Tenn.). Nuclear Sci. and Eng., 14: 37-52(Sept. 1962).

The design of the Experimental Gas-Cooled Reactor fuel assemblies is described and a brief outline of the experimental heat transfer and fluid dynamic studies and mechanical testing is presented. Correlations derived from the experimental data are given, and the results of their application to the fuel element analysis are shown. The hot channel factors are described, and the expected fission gas pressure buildup within the elements is discussed. (auth)

2502 MATERIALS DEVELOPMENT FOR CORE I FUEL ASSEMBLIES FOR THE EXPERIMENTAL GAS-COOLED REACTOR. J. H. Coobs (Oak Ridge National Lab., Tenn.). Nuclear Sci. and Eng., 14: 53-68(Sept. 1962).

An extensive experimental program was conducted on the fuel and cladding for the EGCR fuel elements to establish the adequacy of the design. Methods of inspecting the components and manufacturing the fuel assemblies were developed or perfected. Studies were also conducted on the physical and mechanical properties of the type 304 stainless steel cladding and the UO_2 fuel pellets to provide a basis for predicting the behavior of the elements in service. Data from heat treating of neutron-activated fuel showed that fission-gas release will not be a limiting factor in this design. Out-of-pile thermal-cycling studies on simulated fuel elements established that axial growth of fuel elements at a predictable rate can be expected after the cladding collapses and contacts the fuel pellets, and that characteristic cracking of the UO_2 pellets occurs without displacement of fuel. Impurities in the helium coolant were observed to cause oxidation and carburization of the cladding, but the extent of these reactions can be controlled by regulating the ratios of the impurities. Creep tests at several temperatures indicate that, with the exception of hydrogen, the various impurities will have little detrimental effect on the stress-rupture strength of the cladding. Tube-burst tests in air yielded data that permit a prediction of the life of the fuel element in case of loss of coolant pressure and when compared with results of similar in-pile experiments indicate that irradiation effects reduce the stress-rupture strength of the cladding by as much as 25%. (auth)

2503 EFFECT OF ZERO GRADIENT BOUNDARY CONDITIONS ON CELL CALCULATIONS IN CYLINDRICAL GEOMETRY. W. W. Clendenin (Westinghouse Electric Corp., Pittsburgh). Nuclear Sci. and Eng., 14: 103-4 (Sept. 1962).

The disagreement between computations by various methods of the disadvantage factors of cylindrical rods in certain square lattices has been recently pointed out. The lattices considered were tightly packed and had low-density moderators. Four methods for arriving at the disadvantage factors for four lattices are compared. (W.D.M.)

2504 THEORETICAL STUDY OF REACTIVITY MEASUREMENT OF A REACTOR WITH A REFLECTOR USING A PULSED NEUTRON SOURCE. A. Fraude (Kernforschungszentrum Karlsruhe, Ger.). Nukleonik, 4: 84-91 (1962). (KFK-104). (In German)

For D_2O-moderated reactors with reflectors, the solution of the time-dependent two-group diffusion equation for the relation between the reactivity and the transient behavior of the thermal neutron flux after a single source impulse of fast neutrons is stated in which the flux pattern is described by a time-dependent development of the stationary eigenfunctions. In spite of the increase of the effective neutron lifetime by the reflector, the harmonics of this development decay so quickly that in a specifiable time interval after the impulse, practically only the fundamental waves enter in the measurements. Their decay constants then yield immediately a measure for the reactivity. (tr-auth)

2505 SOME CHARACTERIZATION OF NEUTRON THERMALIZATION IN LATTICES. A. Mockel and J. Devooght (Université Brussels). Nukleonik, 4: 236-50(Aug. 1962). (In English)

Analytical expressions taking into account thermalization effects are given for the effective cross sections and for the age to absorption. The effective cross sections provide a global measure of the measure of the hardening of the spectrum and are compared with previous results. A method (based on Takahashi's equations) to reduce a heterogeneous medium to a homogeneous one is used. Analytical expressions, taking into account both thermalization and transport effects, are given for the disadvantage factor, the effective cross sections, and the migration area in a lattice containing lumped fuel. (auth)

2506 EXACT PERTURBATION THEORY OF SPACE-INDEPENDENT REACTOR KINETICS. Paul Schmid (Eidgenössische Institut für Reaktorforschung, Würenlingen [AG], Schweiz, Ger.). Nukleonik, 4: 251-5(Aug. 1962). (In German)

From the known differential equations for space-independent reactors, it was shown that the relative power breakdown of a reactor diverging exponentially to negative times was described exactly by an integral equation of the Volterra type. The representation selected was distinguished by the fact that both the reactivity as well as the power were interpreted as perturbation magnitudes with independently eligible bases. Without utilization of additional approximations, this representation permits often considerable simplifications of the formulas and the calculation method. The integral equation is suitable for numerical integration with the aid of known calculation programs,

and it is also suitable as a foundation for the derivation of closed analytical expressions. Some examples from reactor engineering practice were explained as an application of the theory. (tr-auth)

2507 THE DESCRIPTIVE FUNCTION OF SUPERCRITICAL REACTORS. H. Uhrig (Kernforschungszentrum, Karlsruhe, Ger.). Nukleonik, 4: 255-7(Aug. 1962). (In German)

The descriptive function of a supercritical reactor was derived and compared, by introduction of an "ersatz" reactor, with that of the straight critical reactors. The results show that the ersatz reactor with smaller relative fraction of delayed neutrons (its mother nucleus decay constants are larger) works comparably with the straight critical reactor. (tr-auth)

2508 POWER OSCILLATIONS OF A REACTOR IN THE PROMPT CRITICAL RANGE WITH STEPPED REACTIVITY PERTURBATIONS. P. Dosch (Kernforschungszentrum, Karlsruhe, Ger.). Nukleonik, 4: 258-63(Aug. 1962). (In German)

In fast ramp-like reactivity perturbations in a reactor and in the presence of prompt negative temperature coefficients, power oscillations occur which lead to a stepped temperature rise. The pattern of this oscillation depends on many reactor parameters and can not be calculated analytically. An approximation calculation was described, and its results were compared with effective processes calculated on an analog computer. In addition, the application of this approximation calculation to the problem—under what conditions does a negative temperature coefficient facilitate the interpretation of a safety system—was described. (tr-auth)

2509 SOLUTION OF THE REACTOR EQUATION FOR A CORE CROSS SECTION WITH A RE-ENTERING ANGLE. Peter Haas (Universität Vienna). Nukleonik, 4: 264-6(Aug. 1962). (In German)

The reactor equation for a bare, homogeneous, stationary reactor was solved approximately. Some simple methods for calculating the geometric curvature and the neutron flux, which yield at reasonable calculation expenditure usable results, are treated. This work should give only reference points and indicate the principal methods. (tr-auth)

2510 A STUDY OF STOCHASTIC KINETICS OF NUCLEAR REACTORS. Abdi Dalfes (Technical Univ. of Istanbul). Nukleonik, 4: 299-303(Oct. 1962). (In English)

The partial differential equation giving the space- and energy-independent probability generating function of the neutron and precursor populations in a reactor at zero power was derived by considering in the stochastic parameter space the transitions which determine the fate of a neutron and a precursor. Kinematic considerations enabled the transformation of the partial differential equation into some previously given forms, thus relating them to the present method of approach. An equation was found which gives the variance of a weighted sum of the state variables and shows that a reactor stationary in the mean is also stationary in the mean square provided a constant neutron source is present. The weighting functions entering the sum are the solutions of the adjoint of the classical kinetic equations. (auth)

2511 A METHOD FOR SOLUTION OF NON-STATIONARY MANY-LAYERED HEAT TRANSFER AND DIFFUSION PROBLEMS WITH CONTROLLED BOUNDARY CONDITIONS. O. Machnig and R. Kuester (Brown Boveri Krupp Reaktorbau G.m.b.H., Ger.). Nukleonik, 4: 306-10 (Oct. 1962). (In German)

An attack was prepared by which the problems of the non-stationary, many-layered, and controlled outer boundary heat transfer and diffusion processes are split into simple single-layered problems and a system of integral equations that have only time as a variable. This system loses explicitness up to an indefinite integration over the given control function by means of a series with conclusive coefficient determination. The prepared method may be used for any geometry. (tr-auth)

2512 FISSION PRODUCT AMOUNTS ORIGINATING BY MEANS OF A POWER EXCURSION OR A REACTOR AND THEIR CONSIDERATION FOR THE ANALYSIS OF A HYPOTHETICAL ACCIDENT. E. Sauter (Siemens-Schuckertwerke A.G., Erlangen, Ger.). Nukleonik, 4: 310-17(Oct. 1962). (In German)

An investigation was made to determine to what extent the fission products originating in the power excursion of a reactor may be considered in comparison with the equilibrium fission product amount for safety calculations. Under very cautious assumptions calculations were made of the fraction of the fission products in the air of the reactor container which may escape in a hypothetical accident without danger to the surroundings. An analysis showed that the permissible fission product release is limited by the fission products taken up by the thyroid. The values depend on reactor operation for various sizes of power excursion and on daily operating times of the reactors. Curves were drawn from which it could be ascertained at which excursion energies the potential danger was as great as that resulting from fission products produced in normal operation. (tr-auth)

2513 RADIATION CONTROL IN NUCLEAR ENGINEERING. J. Le Gall. Tech. Mod., 54: 51-5(Feb. 1962). (In French)

The apparatus built by the Ateliers de Montage Electrique for controlling the level of radiation to which experimental workers and operating and maintenance personnel are subjected in nuclear power plants is described. The control relates to all installations involving radioactive elements. A description is given of apparatus for the control of gamma radiation, fast neutrons, and aerosols. A brief account is given of the equipment constructed for the Triton reactor, E.D.F. I, and E.D.F. II. (auth)

2514 METODY RASCHETA YADERNYKH REAKTOROV. (Calculation Methods for Nuclear Reactors). G. I. Marchuk. Moscow, Gosatomizdat, 1961. 667p.

The principal methods in reactor calculations are presented, and experimental data on critical masses are discussed. The book is divided into eight parts. The first part deals with neutron diffusion under the assumption that all neutrons have identical velocities but differ in vectoral direction. The construction of finite-differential elliptic equations is discussed in the second part. The third part deals with neutron moderation and the fourth with two-group analysis. Effective one-group theory and few-group approximation methods are discussed in the fifth part, and the heterogeneity effects in reactors are analyzed in the sixth. The seventh and eighth parts treat problems on neutron thermalization and homogeneous reactor criticality, respectively. 318 references are included. (R.V.J.)

2515 ANALYTIC CRITICALITY STUDIES ASSOCIATED WITH NEUTRON DIFFUSION THEORY. Henry L. Garabedian (General Motors Corp., Warren, Michigan). Review Series No. 26 of "Developments in the Peaceful Applications of Nuclear Energy" of the International Atomic Energy Agency, Vienna. Sept. 1962. 63p. (STI/PUB/15/26). $1.00(IAEA).

Criticality studies associated with nuclear reactors are

discussed. Analytic criticality studies associated with neutron diffusion theory are examined along with those associated with neutron transport theory and those associated with digital computer codes based on finite difference techniques. Each of these areas of nuclear reactor theory is of vital importance in the design, operation, and understanding of nuclear reactors, and no one of them should be emphasized to the point of neglect of the others. The review is devoted solely to methods of diffusion theory in reactor criticality, and is primarily concerned with the history and development of basic researches in this field, including developments of recent years and some hitherto unpublished research. Most of the difficulties associated with reactor criticality calculations, beyond the elements of the subject, stem from the heterogeneities of reactor configurations. The development of analytic methods designed to overcome some of these geometric difficulties is emphasized. (auth)

2516 ADVANCES IN NUCLEAR SCIENCE AND TECHNOLOGY. VOLUME 1. Ernest J. Henley and Herbert Kouts, eds. New York, Academic Press Inc., Publishers, 1962. 362p. $12.00.

Seven critical review-type papers are presented on work in the fields of nuclear science and engineering. The papers cover the following topics: nuclear power stations, a graphite-moderated boiling superheat reactor, radioinduced graft polymerization, diffusion in uranium, large boiling reactors, economics of nuclear power, and chemonuclear reactors. Separate abstracts were prepared for six of the papers; the other paper was previously abstracted in NSA. (D.L.C.)

2517 THERMODYNAMIC ANALYSIS OF NUCLEAR POWER STATIONS. Seymour Baron (Burns and Roe, Inc., New York). p.1-35 of "Advances in Nuclear Science and Technology." New York, Academic Press Inc., Publishers, 1962.

A review is presented on the thermodynamic analysis and economics of nuclear power stations. The operation, performance, and cycles of nuclear power stations are described. Steam cycle efficiencies are compared for the various reactor types at constant heat output. Auxiliary power requirements, which cut down on the improvement in efficiency by use of higher steam pressures and temperatures, are considered. Overall heat cycle efficiencies for various reactors are discussed. Turbine design for low-temperature reactors is considered, and ways of removing moisture from wet steam are discussed. Finally, the economics of superheat, moisture separation, and high-pressure steam is discussed. (D.L.C.)

2518 THE GBSR: A GRAPHITE MODERATED BOILING WATER STEAM SUPERHEAT REACTOR. L. S. Mims and D. J. Stoker (Atomics International, Canoga Park, Calif.). p.37-83 of "Advances in Nuclear Science and Technology." New York, Academic Press Inc., Publishers, 1962.

A summary description of the 300-Mw(e) GBSR plant is presented. The GBSR concept is discussed with reference to the moderator, heat transfer, physics, fluid, design, and radioactive carry-over. The advantages and disadvantages of the reactor concept are outlined. Finally, the design and economics of the 300-Mw(e) GBSR plant are reviewed in detail. (D.L.C.)

2519 RADIATION-INDUCED GRAFT POLYMERIZATION. George Odian and Horace W. Chandler (Radiation Applications Inc., Long Island City, N. Y.). p.85-109 of "Advances in Nuclear Science and Technology." New York, Academic Press Inc., Publishers, 1962.

A review is presented on the synthesis of graft copolymers by radioinduced graft polymerization. Grafting techniques involving the mutual irradiation of monomer and polymer and the pre-irradiation of the polymer alone are considered. Mechanisms of graft polymerization are discussed. A large number of grafted copolymers are tabulated with their yields, and the effects of polymer structure on the grafting rate are discussed. The effects of additives are also considered. The properties of some well-known graft copolymers are reviewed. (D.L.C.)

2520 PERFORMANCE CHARACTERISTICS OF LARGE BOILING WATER REACTORS. G. M. Roy and E. S. Beckjord (General Electric Co., San Jose, Calif.). p.179-223 of "Advances in Nuclear Science and Technology." New York, Academic Press Inc., Publishers, 1962.

The problems and characteristics of the Dresden boiling water reactor are reviewed with reference to central station use. A description of the Dresden plant is given. Some of the physics test results are summarized. Stability analysis of boiling reactors is reviewed, and results of stability tests for Dresden are given. Power distribution and measurement are considered briefly. The load-following and operating characteristics of Dresden are described. (D.L.C.)

2521 ECONOMICS OF NUCLEAR POWER. John E. Ullman (Hofstra Coll., Hempstead, N. Y.). p.225-46 of "Advances in Nuclear Science and Technology." New York, Academic Press Inc., Publishers, 1962.

A detailed analysis of nuclear power prospects today is presented with examination of the technological, economical, social, and political factors involved. Future costs of conventional plants and fuels are considered in detail. Various reactor types and their prospects are discussed. The effects of fixed costs on cost of power generation are discussed briefly. Other methods of power generation are described. Forecasting of future demand for electric power is considered, with a detailed examination of the factors and assumptions involved. Nuclear power should be competitive by 1965. (D.L.C.)

2522 CHEMONUCLEAR REACTORS AND CHEMICAL PROCESSING. Meyer Steinberg (Brookhaven National Lab., Upton, N. Y.). p.247-333 of "Advances in Nuclear Science and Technology." New York, Academic Press Inc., Publishers, 1962.

The various possible types of chemonuclear reactors are described, and a nomenclature classification of all the possible types is given. Radiation and fission fragment chemistry is reviewed. Considerations involved in the design of a fission fragment chemonuclear reactor are discussed in detail, and various types of the fission fragment reactor are described. Separation and decontamination of the chemical products from the fuel are considered. Neutron-gamma chemonuclear reactors are discussed briefly. Several possible chemonuclear processes are discussed in detail: N_2 fixation, CO_2 cracking, ethylene glycol production, phenol production, and hydrazine production. An economic assessment of N_2 fixation and other processes by chemonuclear means is made. Thermochemonuclear and electrochemonuclear reactors are considered briefly, along with the use of chemonuclear reactors in power production cycles. (D.L.C.)

2523 NUCLEAR SAFETY. Volume 4, No. 1. William B. Cottrell, ed. (Oak Ridge National Lab., Tenn.). Sept. 1962. 121p. (GPO) $0.55 (domestic), $0.70 (foreign). (One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC).

A review of topics relevant to the analysis and control of hazards associated with reactor operation is presented.

Separate abstracts were prepared for topics of interest under the general subjects safety criteria, accident analysis, control, plant safety features, activity release, and current events. (J.R.D.)

2524 HYDRODYNAMIC STABILITY IN REACTORS. Eric S. Beckjord (General Electric Co., Palo Alto, Calif.). Nucl. Safety, 4: No. 1, 1-10(Sept. 1962).

Recent experiments concerning reactor hydrodynamic stability are reviewed. Present knowledge of factors which contribute to reactor instability is discussed, and research to clarify inconsistencies of reported data is suggested. (J.R.D.)

2525 REACTOR SITE CRITERIA. William B. Cottrell (Oak Ridge National Lab., Tenn.). Nucl. Safety, 4: No. 1, 11-16(Sept. 1962).

A discussion is presented in which criteria of reactor location are considered. Issues such as multiple reactors at one site, relations of isolation and safety features, aspects of mobile reactor safety, population growth problems, and relations of population center and reactor location are examined. A guide is proposed in which safe practices will be compiled for ready reference. (J.R.D.)

2526 HAZARDS OF FAST-BURST FACILITIES. P. H. Pitkanen (Oak Ridge National Lab., Tenn.). Nucl. Safety, 4: No. 1, 16-20(Sept. 1962).

A discussion is presented concerning the hazards that are associated with the GODIVA reactors and their descendants. It is noted that safe operation of such reactors depends on well-trained personnel, good procedures, and incorporation of good instrumentation and interlocks. (J.R.D.)

2527 BURNOUT IN BOILING HEAT TRANSFER. W. R. Gambill (Oak Ridge National Lab., Tenn.). Nucl. Safety, 4: No. 1, 30-5(Sept. 1962).

A review of selected developments concerning boiling burnout is presented. Data and information are included on pool-boiling burnout, subcooled forced-convection burnout, bulk-boiling forced-convection burnout, and burnout in liquid-metal systems. (J.R.D.)

2528 FISSION-PRODUCT RELEASE FROM UO_2. R. M. Carroll (Oak Ridge National Lab., Tenn.). Nucl. Safety, 4: No. 1, 35-42(Sept. 1962).

The safe operation of a clad UO_2 fuel element depends to a great extent on a knowledge of fission gas behavior. It is noted that fission gas release from UO_2 is not well understood. A discussion of information on factors in fission gas behavior is presented. Present data indicate that fission-gas release will not amount to more than 1% if the highest UO_2 temperature is less than 1500°C, the burnup does not exceed 30,000 Mwd/t, and thermal cycling is not excessive. (J.R.D.)

2529 RADIATION EMBRITTLEMENT OF REACTOR PRESSURE VESSELS. M. S. Wechsler and R. G. Berggren (Oak Ridge National Lab., Tenn.). Nucl. Safety, 4: No. 1, 42-57(Sept. 1962).

A review of the safety aspects of reactor pressure vessel embrittlement is presented. Low-temperature brittleness is examined and data and information concerning radiation effects on properties of pressure vessel materials are discussed with the emphasis on fundamentals of radiation damage. (J.R.D.)

2530 FUEL-ELEMENT LEAK DETECTION. J. L. Kaufman (Oak Ridge National Lab., Tenn.). Nucl. Safety, 4: No. 1, 58-60(Sept. 1962).

The design and operation of devices for detection and location of fuel element failure are discussed. The discussion mainly concerns an automatic chromatograph, and applications of isotopic exchange columns. Included are discussions concerning methods for detection of failed pool type reactor fuel elements, and application of commonly used devices to new reactors. (J.R.D.)

2531 COST AND EFFECTIVENESS OF AIR-CLEANING SYSTEMS. M. W. First and L. Silverman (Harvard Univ., Boston). Nucl. Safety, 4: No. 1, 61-6(Sept. 1962).

It is noted that since high-performance air cleaning is costly and is unavoidable from a safety standpoint at nuclear facilities, wise equipment selection and careful operating procedures are required for maximum economy. Analysis of operating costs for ultra-high efficiency filters shows that a single expensive replacement can dominate the total cost picture. Discussions of fractional breakdowns to show ways of minimizing annual expenses are included. (J.R.D.)

2532 SAFETY IN URANIUM MINING AND MILLING. F. J. Hurst (Oak Ridge National Lab., Tenn.). Nucl. Safety, 4: No. 1, 68-72(Sept. 1962).

Discussions are included concerning exposure standards and protection regulations, and radiation hazards in mines and mills. It is noted that hazards were recognized and protective regulations were promulgated. Areas of great importance are control of radon daughters, dust control and waste disposal. (J.R.D.)

2533 HYDROGEN HAZARDS IN GRAPHITE REACTORS. L. G. Overholser (Oak Ridge National Lab., Tenn.). Nucl. Safety, 4: No. 1, 72-5(Sept. 1962).

A review of information concerning the lower limit of reaction in mixtures of air, H_2, steam, and He is presented. Information is also included on the production rate for H_2 by the steam-graphite interaction. It is noted that available data are incomplete and in some cases contradictory. (J.R.D.)

2534 ESTIMATION OF ACCIDENT PRESSURE AND TEMPERATURE RISES IN CONTAINMENT VESSELS. A. R. Edwards. Nucl. Safety, 4: No. 1, 75-80(Sept. 1962).

A discussion of events that could follow loss of primary reactor fluid is presented to show a method of determining the maximum accident pressure and thus obtain a basis for containment-vessel design. The general theory is examined and development of an alignment chart for solution of internal energy balance in vessels is discussed. (J.R.D.)

2535 AEC RADIOLOGICAL ASSISTANCE PROGRAM. F. R. Zintz (U. S. Atomic Energy Commission, Washington, D. C.). Nucl. Safety, 4: No. 1, 81-6(Sept. 1962).

Organization of the program is described along with the events associated with its inception. A joint agreement between AEC and DOD provides for radiological emergency activities through a coordinating center at Albuquerque, N. M., where teams are available for assistance at radiation incident areas. Operation of the assistance program is described and examples of incidents are given. (J.R.D.)

2536 FRENCH STUDIES OF ADSORPTION BY SOILS. C. Gailledreau (Service de Contrôle des Radiations et de Génie Radioactif, Saclay, France). Nucl. Safety, 4: No. 1, 86-8(Sept. 1962).

It is noted that at present, the more highly radioactive waste sludge in France is stored in drums. Investigations concerning ultimate disposal of this and other waste are described. Discussions of site surveys and investigation of ground disposal are included. (J.R.D.)

2537 YANKEE REACTOR OPERATING EXPERIENCE. J. F. Kaslow (Yankee Atomic Electric Co., Boston). Nucl. Safety, 4: No. 1, 96-103(Sept. 1962).

Through March 1962, this plant generated over one billion kwh of electricity using the original core loading.

Discussion of outage time is included along with comments on plant design, performance, and modifications. Operating verification of plant design was provided by the plant, and a demonstration of safe dependable power production is being achieved. (J.R.D.)

2538 HANFORD REACTOR INCIDENTS. J. R. Buchanan (Oak Ridge National Lab., Tenn.). Nucl. Safety, 4: No. 1, 103-7(Sept. 1962).

Incidents which occurred at the Hanford reactors in 1954, 1955, and 1956 are reviewed. Analysis of events revealed that the automatic safety equipment performed well and appears reliable. Well-trained personnel and extra care in startup are thought to be of the greatest importance in reactor operation. (J.R.D.)

2539 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS AND TO FUEL ELEMENTS THEREFOR. George Harrison Inglis (to C. A. Parsons and Co. Ltd.). British Patent 907,246. Oct. 3, 1962.

A reactor fuel element construction of the elongated, finned type is designed with coupling between the elements. The coupling comprises a flexible cable, one end fixed to one element and the other free to slide in a recess in the other element. When the coupled elements are lifted, a member at the freely sliding end of the cable comes into contact with a stop, whereby the load is transmitted to the cable. (D.L.C.)

2540 NUCLEAR FUEL ASSEMBLY. (to U. S. Atomic Energy Commission). British Patent 907,270. Oct. 3, 1962.

A fuel assembly is designed for use in a gas suspension reactor. The assembly comprises a tubular member closed at its bottom and containing the internals of the assembly. A reactive core forms a lower plenum with the closed bottom, and a reflector is located above the core. Inlet and outlet means are provided together with shielding in the upper part of the tubular member. (D.L.C.)

2541 A TWO-SPEED DEVICE. (to U. S. Atomic Energy Commission). British Patent 907,278. Oct. 3, 1962.

A screw-and-nut gearing is designed for driving a follower at two different speeds. The gearing has two threaded screws, one within the other, and the threads are arranged so that when the outside screw moves up and down by rotation, the interior screw moves at a faster rate. The gearing is suitable for controlling the insertion of a safety plus into the bottom of a reactor, where the plug can be inserted relatively fast up to a certain point and then slowly thereafter. (D.L.C.)

2542 IMPROVEMENTS IN METHODS AND DEVICES FOR SECURING FUEL ELEMENTS IN NUCLEAR REACTOR TUBULAR CHANNELS. Bertrand Roger Georges Guibert (to Commissariat à l'Énergie Atomique). British Patent 907,344. Oct. 3, 1962.

A reactor fuel assembly for heavy-water reactors is designed with means for securance in a reactor passage. The means comprises a key fixed to one end of the fuel assembly and a grooved ring which is locked to the key outside the passage in such a way that unlocking in the passage is impossible. The assemblies are lowered into the passage and then fixed in position by crimping the passage wall in the region of the ring grooves. (D.L.C.)

2543 IMPROVEMENTS IN OR RELATING TO THE CONTROLLING OF NUCLEAR REACTORS. Leslie Reginald Blake (to United Kingdom Atomic Energy Authority). British Patent 907,391. Oct. 3, 1962.

A control system is designed for reactors of the fast and materials testing types. The system operates by displacing bodily sections of the core in a direction transverse to the coolant flow direction. Each section is associated with inclined surfaces so that it tends to move under gravity to the dispersed position for reducing the reactivity. Means are provided for holding the sections in the concentrated positions until a fall in the coolant pressure occurs. (D.L.C.)

2544 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Leslie Reginald Blake (to United Kingdom Atomic Energy Authority). British Patent 907,392. Oct. 3, 1962.

A reactor of the fast and materials testing type is designed whose fuel elements are movable transversely between loading and unloading stations, the unloading station being located laterally outside the core region. The advantages of such a reactor is that loading and unloading are effected outside the core so that their effects on reactivity is minimized, and that the reactor can be controlled by moving the core sections apart, as described in British Patent 907,391. (D.L.C.)

2545 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Leslie Reginald Blake (to United Kingdom Atomic Energy Authority). British Patent 907,393. Oct. 3, 1962.

A reactor fuel plate for use in arrays is designed which permits some distortion or swelling without interference with coolant flow. The plate comprises a fuel member enclosed by a sheath in two sheet parts, and the side edge portions of both parts are turned inwardly and secured to each other so that the turned-in portions function as edge plugs of the sheath which yield outwardly on expansion of the fuel member. The sheath is also provided with outwardly projecting ribs for spacing the plate from adjacent plates to provide coolant flow paths therebetween. Clearance is left between the sheath ends and the fuel member for endwise growth of the fuel member. A box-like container for holding an array of fuel plates is described. (D.L.C.)

2546 IMPROVEMENTS IN OR RELATING TO THE CONTROLLING OF NUCLEAR REACTORS. Leslie Reginald Blake (to United Kingdom Atomic Energy Authority). British Patent 907,394. Oct. 3, 1962.

A fast reactor is designed with a control system which is actuated by a fall in the coolant pressure. Means for holding the fuel elements in the critical position against a bias towards a non-critical position is provided which is powered by the coolant flow. On failure of the coolant flow, the fuel elements are moved by gravity to non-criticality. (D.L.C.)

2547 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Shepherd Rigg (to United Kingdom Atomic Energy Authority). British Patent 907,458. Oct. 3, 1962.

A reactor circuit loop facility for CO_2-cooled reactors is designed with means for inducing coolant circulation in the loop in event of blower failure. The loop has a reservoir of high-pressure CO_2 and nozzle means for injecting the CO_2 into the loop for restoring the coolant circulation. (D.L.C.)

2548 IMPROVEMENTS RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Graham Coates, Clive Frederick George Dupen, and Frederick Wilde (to A.E.I.-John Thompson Nuclear Energy Co. Ltd.). British Patent 907,535. Oct. 3, 1962.

A reactor fuel assembly comprising a plurality of fuel rods is designed. Each rod is suspended from a support at its upper end, and each support has horizontal arms with

recesses or projections for engaging adjacent supports. A band encircling the supports is used to clamp them together to form a structure, and lugs are provided on the band to engage slots in the wall of the fuel channel. (D.L.C.)

2549 IMPROVEMENTS IN NUCLEAR FUEL ELEMENTS. Michel Aubert, Sebastian Foglia, and Roland Roche (to Commissariat à l'Énergie Atomique). British Patent 907,625. Oct. 10, 1962.

A reactor fuel element is designed so that its fuel member supports only its own weight without complicated mechanical means. The element comprises a fuel member, a sleeve surrounding the fuel member, and non-rigid means for supporting the fuel member in the sleeve. The supporting means comprise transverse wires holding a centering, supporting disc within the sleeve. (D.L.C.)

2550 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. John Norman Cooper, Thomas Arthur Seeley, and Victor Paul Koller (to United Kingdom Atomic Energy Authority). British Patent 907,735. Oct. 10, 1962.

A thermocouple connection arrangement is designed for measuring temperatures at inner fuel elements in a fuel assembly. In the arrangement, an inner element is equipped with a thermocouple and a cable with electric contacts at one end of the element, and the other elements above have contacts at both ends with cable connections in between. The assembly is terminated at the top by a telescopic member with end contacts for connecting the thermocouple with contacts outside the reactor. (D.L.C.)

2551 IMPROVEMENTS RELATING TO SAFETY DEVICES FOR NUCLEAR REACTORS. John Raymond Dean and Charles Theodore Geeson (to Reyrolle and Co. Ltd.). British Patent 908,059. Oct. 10, 1962.

A shutdown device for gas-cooled reactors is designed which is operated automatically in response to abnormal conditions in the reactor and independently of the electrical safety circuits of the reactor. The device comprises a latch for suspending a control rod above a reactor channel, and a mechanism for releasing the latch. The mechanism is responsive to the rate of fall of gas pressure. (D.L.C.)

2552 A PROCESS OF AND AN APPARATUS FOR THE PURIFICATION OF A GAS OR GAS MIXTURE. (to Gesellschaft für Linde's Eismaschinen Aktiengesellschaft Zweigniederlassung Höllriegelskreuth). British Patent 908,069. Oct. 17, 1962.

A gas purification apparatus is designed for the separation of radioactive and non-radioactive impurities from gaseous reactor coolants. In the apparatus, H_2 and/or CO in the coolant is oxidized in a catalyst unit, the coolant is cooled, non-radioactive impurities are separated in gel dryers at temperatures between 0 and −70°C, and radioactive impurities are separated in adsorbers below −70°C. (D.L.C.)

2553 IMPROVEMENTS IN OR RELATING TO CHARGE-DISCHARGE ARRANGEMENTS FOR A GAS-COOLED HETEROGENEOUS NUCLEAR REACTOR. James Lewis Ayre (to Simon-Carves Ltd. and General Electric Co., Ltd.). British Patent 908,130. Oct. 17, 1962.

A charge-discharge arrangement for gas-cooled reactors is designed which uses the pressure differential across a fuel channel to levitate the fuel elements from the channel. The arrangement comprises an auxiliary vessel with storage facilities, a charge tube, and blower and valve means for controlling the pressure differential to effect fuel element transfer. Means is also provided for guarding against blower failure. (D.L.C.)

2554 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Michael Davis, Colin Boorman, Brian Stapleton, William Charles Leonard Kent, and Thomas Arthur Seeley (to United Kingdom Atomic Energy Authority). British Patent 908,180. Oct. 17, 1962.

A reactor fuel element of the elongated, finned type with the ends equipped for stacking end to end is designed with means for restraining the element against coolant-flow-induced vibration in a fuel channel. The element is provided with a member extending part way around the periphery of the element so that the coolant flow exerts a lateral force on the member to move the element into a stable position. Three embodiments of the member are described. (D.L.C.)

2555 NUCLEAR REACTOR. (to Brown, Boveri and Cie, Aktiengesellschaft and Beteiligungs-und Patentverwaltungsgesellschaft Mit Beschrankter Haftung). British Patent 908,278. Oct. 17, 1962.

A ball-fueled, gas-cooled reactor is designed in which the reactivity would not increase uncontrollably in event of collapse of the top part of the reflector. The top part has a central hole for filling the reactor with the fuel balls and has its inner surface shaped as a hollow cone so that the walls of the cone are parallel to the upper surface of the fuel charge. A space equal to one to three times the diameter of the fuel balls is maintained between the reflector top and the top of the fuel charge. (D.L.C.)

2556 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Everett Long, John Tatlock, and John Michael Laithwaite (to United Kingdom Atomic Energy Authority). British Patent 908,305. Oct. 17, 1962.

A moderator structure for gas-cooled, graphite-moderated reactors is designed so that problems due to radioinduced dimensional changes are made less acute. The columns formed by vertically stacked graphite blocks are individually carried from above by support wires or rods anchored to a box grid support structure at the top of the pressure vessel. (D.L.C.)

2557 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR CONTROL ELEMENTS. Frank Marsden Leslie (to United Kingdom Atomic Energy Authority). British Patent 908,456. Oct. 17, 1962.

An emergency shutdown device for pressurized gas-cooled reactors is designed which is not adversely affected by disarrangement or misalignment of the core such as would be caused by a breach in the coolant circuit. The device comprises a container housing two members of neutron-absorbing material, the first member being a tube and the second member being boron steel shot held within the tube by a diaphragm-valve plug arrangement. The whole device is positioned within a core channel, and in the event of a sudden reduction in gas pressure, the shot is released to increase the neutron absorption capacity of the device. (D.L.C.)

2558 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Arthur Firth and Walter John Cairns (to United Kingdom Atomic Energy Authority). British Patent 908,534. Oct. 17, 1962.

Core pressure tubes for pressurized reactors are designed with transverse corrugations along their lengths for greater robustness. The difference between the minimum internal and maximum external radii of the tubes should not be more than twice the tube wall thickness, and the pitch of the corrugations should be more than 0.4 of the minimum internal diameter of the tubes. (D.L.C.)

2559 UNLOADING DEVICE, PARTICULARLY FOR FUEL ELEMENTS OF NUCLEAR REACTORS. Sebastien Foglia (to Commissariat à l'Énergie Atomique). Canadian Patent 638,645. Mar. 20, 1962.

A device is designed for removing, from a reactor, damaged fuel rods, sheaths, or control rods. The device comprises a heavy cylindrical body provided at the bottom with three vertical fingers, each of which has a recess with a ball on its face contacting the element to be removed. In operation, the fingers are lowered into the space between a fuel rod and its graphite sheath and then raised, whereby the balls are wedged between the recesses and the rod and/or sheath, thereby forming a gripping surface. (D.L.C.)

2560 CONSTRUCTION OF THE COVER OF A HETEROGENEOUS REACTOR. Lars Leine and Kristain D. Madsen (to Allmanna Svenska Elektriska Aktiebolaget). Canadian Patent 640,203. Apr. 24, 1962.

A reactor cover is designed for a heavy-water-cooled and -moderated reactor of the type described in Swedish Patent 168,784. The moderator and cooling system are accommodated in a thin-walled container of, e.g., aluminum, which in turn is surrounded by a reflector and another container. The cover is provided with a collecting vessel for the outgoing coolant, and the fuel elements are suspended from the cover. (D.L.C.)

2561 FUEL ELEMENT STRUCTURE FOR ATOMIC REACTORS. Marc Salesse and Jacques Stohr (to Commissariat à l'Énergie Atomique). Canadian Patent 640,917. May 8, 1962.

A reactor fuel element is designed for increased cooling surfaces. The element comprises several rods of relatively small diameter and grouped into a bunch; the connections between them are made by extensions of the rod sleeves. These extensions may be made by plastic deformation, precision casting, or extrusion. Several embodiments of the element are described. (D.L.C.)

2562 COMBINED NUCLEAR REACTOR-SPENT FUEL COOLING ARRANGEMENT. Werner B. L. K. Bellermann and Hermann Dingerdissen (to Brown, Boveri and Cie. A. G. and Beteiligungs- und Patentverwaltungs-gesellschaft mit Beschrankter Haftung). Canadian Patent 641,612. May 22, 1962.

A reactor fueled with ceramic bodies in the form of cylinders, balls, etc., is provided with a cooling pan below the core for the radioactive cooling of fuel bodies removed from the core. Discharge devices are provided for controlling the delivery of fuel bodies from the core to the pan and from the pan to outside the reactor. The pan is cooled by the reactor cooling system. (D.L.C.)

2563 FISSION PROCESS IN A HOMOGENEOUS NUCLEAR REACTOR. Jan J. Went (to Stichting Reactor Centrum Nederland). Canadian Patent 645,742. July 31, 1962.

A homogeneous reactor using a suspension of UO_2 in D_2O may be operated so that the waste of neutrons is kept low while keeping the conversion factor at least equal to unity. In the reactor, the initial proportion between the moderator and fissile material is selected so that the susceptibility of the reactivity to fluctuations in the proportion is minimized, and the reactor is kept critical throughout its life by gradually increasing the moderator-fissile material proportion. The fissile material may be diluted with a fertile material. (D.L.C.)

2564 FUEL ELEMENT FOR AN ATOMIC REACTOR AND METHOD OF PRODUCING IT. Maurice Gauthron and Jacques Stohr (to Commissariat à l'Énergie Atomique). Canadian Patent 646,716. Aug. 14, 1962.

A method for making sheathed reactor fuel elements is given which results in greater strength for a given sheath thickness. The method comprises stacking a series of fuel rods in which the diameter of alternate rods is greater than that of the other rods, enveloping the series of rods in a sheath, and deforming the sheath to hold each rod relative to its adjacent rods. Longitudinal folds are also formed which stiffen the element. (D.L.C.)

2565 FUEL ELEMENTS FOR NUCLEAR REACTORS. Jacques-André Stohr and Maurice Gauthron (to Commissariat à l'Énergie Atomique). Canadian Patent 646,735. Aug. 14, 1962.

A reactor fuel element is designed with an annular construction for improved heat transfer. The element comprises two concentric annular sheaths between which are located abutting annular fuel bodies held in position by deformation of one or both sheaths. The bodies may be of varying thickness, neighboring bodies being of unequal and alternate bodies of equal thickness. (D.L.C.)

2566 END STRUCTURE OF NUCLEAR FUEL CARTRIDGES. Lucien Alfille and Jean Ropers (to Commissariat à l'Énergie Atomique). Canadian Patent 646,772. Aug. 14, 1962.

A reactor fuel cartridge of the sheathed type is designed with a strengthened end structure so that a plurality of cartridges may be stacked without deformation of the ends. In the end structure, the plug closing the lower end is provided with at least one binding of a (refractory) material more resistant to flow than the plug material, which is generally the same as the sheath material, usually a Mg alloy. The binding may be in the shape of collars fitted over the plug, reinforcing rings sunk into the interior of the plug, etc.; several embodiments of possible bindings are described. (D.L.C.)

2567 MODERATOR STRUCTURE FOR NUCLEAR REACTORS. Roger Martin (to Commissariat à l'Énergie Atomique). Canadian Patent 647,170. Aug. 21, 1962.

A graphite moderator structure is designed with a novel key arrangement which results in better stability, coolant sealing, and ease of machining of the graphite bars. In the key arrangement, each hexagonal bar has a plurality of grooves located at its corners, and a Y-shaped key engages each groove and the grooves of two adjacent bars. Distance pieces are provided for maintaining a constant spacing between the keys around a bar, and one key may engage in the grooves of two coaxial bars in a stack to keep the coolant bores in alignment. (D.L.C.)

2568 HETEROGENEOUS NUCLEAR REACTOR. Hermann Kumpf (to Siemens-Schuckertwerke Aktiengesellschaft). Canadian Patent 647,277. Aug. 21, 1962.

A liquid-cooled reactor is designed for more effective utilization of the negative temperature coefficient of the moderating coolant for self-stabilization. In the reactor, a portion of the moderator space, generally in the core zone, is separated from the rest of the moderator space and connected into the coolant circulation system at a hot location, so that the portion is traversed by hot coolant. The reactor design is particularly effective for boiling-water reactors. (D.L.C.)

2569 NUCLEAR REACTOR GUIDE TUBES. Hermann Kumpf and Hans-Peter Schabert (to Siemens-Schuckertwerke A. G.). Canadian Patent 647,974. Sept. 4, 1962.

A reactor guide tube for containing stacked columns of fuel elements is adapted for preventing the elements from oscillating or bouncing against each other, particularly during the charging and discharging operations. The guide tube is provided with a barrier at the exit and with a free-floating throttle beneath the elements. (D.L.C.)

2570 NUCLEAR REACTOR INCORPORATING MEANS FOR COOLING WALLS OF TUBES. William M. Brown (to

Canadian General Electric Co., Ltd.). Canadian Patent 648,551. Sept. 11, 1962.

A heavy water-cooled, calandria-type reactor is designed with means for cooling the inner walls of the calandria tanks and the external walls of the coolant tubes above the moderator level. The means comprise a ring manifold and a dribble header. Thus, the reactor may be constructed out of inexpensive materials having low neutron capture cross sections but low strength at high temperatures. The coolant is preferably organic. (D.L.C.)

2571 NUCLEAR PLANT PROVIDED WITH AN EXPANSIBLE GAS HOLDER. Jan J. Went and Bernard L. A. van der Schee (to Stichting Reactor Centrum Nederland). U. S. Patent 3,056,736. Oct. 2, 1962.

In order to prevent radioactive substances from leaking to the outside environment, a reactor may be enclosed in a gas-tight enclosure connected to an expansible gasholder which is at some distance from the reactor. The gasholder may be provided with means for condensing some of the gases. In an alternative embodiment, the reactor may be located at the lower part of a dry gasholder. (D.L.C.)

2572 TRANSFER MECHANISM FOR NUCLEAR REACTORS. Erling Frisch (to Westinghouse Electric Corp.). U. S. Patent 3,058,900. Oct. 16, 1962.

A transfer mechanism for exchanging fuel elements is designed for use in pressurized reactors. The mechanism comprises an inclined tubular conduit with one end inserted through the reactor vessel wall and the other end in a water canal below the reactor. In unloading a fuel element, the element is raised from the core, lowered into the upper end of the mechanism, and then moved by pressurized water to the water canal. Means are provided for preventing leakage of fluid from the reactor vessel into the canal both during reactor operation and use of the mechanism. The mechanism is accessible for easy maintenance and repair. (D.L.C.)

Power Reactors

Refer also to abstract 1810.

2573 (ACNP-62002) FULL SCALE CLOSURE TEST. J. F. Patterson, S. P. Wnuk, and E. A. Bemis (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Sept. 20, 1962. For Northern States Power Co., Minneapolis and Central Utilities Atomic Power Associates. Sept. 20, 1962. Contract AT(11-1)-589. 148p.

The tests performed on a full-scale prototype of the closure designed for the Pathfinder reactor vessel are described. This head was bolted to another head designed to simulate the reactor vessel. The design pressure of the facility is 700 psig at 500°F. Strain gages and brittle coatings were used to determine the stresses in the closure. Dial indicator gages were used to measure flange rotation after the head was secured and while it was subjected to hydrostatic pressure. Tests were performed at reactor operating temperature and pressure to evaluate the closure and gasketing. The vessel was thermal cycled, and temperature gradients in the head measured to establish allowable heating and cooling rates. Hydraulically operated bolt tensioners were used to seal and open the closure. Special tools and procedures were developed for underwater operation. (auth)

2574 (BNL-6308) PLUTONIUM FUELLED THERMAL REACTORS WITH HIGH CONVERSION RATIOS. J. Chernick and G. Srikantiah (Brookhaven National Lab., Upton, N. Y.). [nd]. Contract [AT(30-2)-Gen-16]. 6p.

A study concerned with the adaptability of current reactor types to the use of Pu fuel is reported. Data are included on initial breeding ratios for Pu^{239}. It is noted that desirable characteristics for these reactors include good neutron economy and low Pu inventory. (J.R.D.)

2575 (DANATOM-04-62) N.T. ALPHA II. A 65000 DWT TANKER. A REVISION. (Danish Assn. for Industrial Development of Atomic Energy, Hellerup). Aug. 1962. 70p.

A revision of the previous Alpha 65,000 DWT Tanker design study is presented. The reactor system which is described is thought to be suitable for full-scale application. Included are studies of costs, reactor specifications, shielding, propulsion system, refueling, and waste disposal. (J.R.D.)

2576 (GAMD-3254) THE CONTRIBUTION TO THE EBOR PROMPT TEMPERATURE COEFFICIENT DUE TO THE DOPPLER BROADENING OF U-235 RESONANCES. A. D. McWhirter and A. J. Goodjohn (General Atomic Div., General Dynamics Corp., San Diego, Calif.). June 25, 1962. Contract AT(04-3)-187. 14p.

The temperature coefficient of reactivity caused by the Doppler broadening of U^{235} resonances was calculated for the EBOR. Assuming that the NRIA approximation applies in a loading of 100 kg U^{235} and 89 kg U^{238}, the contribution to the prompt coefficient by U^{235} is negative and about an order of magnitude less than the U^{238} contribution at 300 and 980°K. (J.R.D.)

2577 (GNEC-214) BOILING NUCLEAR SUPERHEATER (BONUS) POWER STATION TECHNICAL SPECIFICATIONS. Frank Bevilacqua (General Nuclear Engineering Corp., Dunedin, Fla.). Oct. 26, 1962. Contract AT(40-1)-2674. 103p.

The proposed technical specifications for the Boiling Nuclear Superheater (BONUS) Power Station are given. Specifications are given for site, containment, reactor water coolant system, reactor steam coolant system, reactor pressure control system, reactor core design, reactor core heat transfer, principal reactivity effects in the reactor, safety and control systems, general design features and specific operating limits of the monitoring systems, waste disposal systems, reactor auxiliary systems, ventilation, fuel transfer and storage, and administrative and procedural safeguards. (M.C.G.)

2578 (HW-68420(Rev.)) ECONOMIC EVALUATION OF A 300-Mw(e) SUPERCRITICAL PRESSURE POWER REACTOR. H. Harty, J. J. Regimbal, F. G. Toyoda, and R. D. Widrig (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). June 1961. Contract AT(45-1)-1350. 176p.

A conceptual design of a 300-Mw(e) Supercritical Pressure Power Reactor (SPPR) was completed. The reactor utilizes the inverted cluster-type fuel element as the pressure member. Operating with turbine conditions of 3500 psi and 1050°F with two reheats to 1000°F, the direct-cycle power plant achieves a net thermal efficiency of 43%. Based on the pre-July, 1961, uranium price schedule, unit power costs of 6.56 mills/kwh were attained when calculated in accordance with the Nuclear Power Plants Cost Evaluation Handbook. Capital costs of $175 per net kw were obtained. The revised uranium price schedule resulted in power costs estimated at 6.09 mills/kwh. Capital costs of about $150 per net kw appear attainable with this concept. The major unknown in the SPPR concept is the long-term (25,000 to 40,000 MWD/MT), high temperature irradiation behavior of the fuel element. (auth)

2579 (IDO-16756) STABILITY AND TRANSIENT ANALYSIS OF THE EOCR. S. R. Gossmann, K. V. Moore, and F. K. Hyer (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Aug. 24, 1962. Contract AT(10-1)-205. 53p.

The dynamic characteristics of the EOCR plant are investigated at full power (40 Mw). The stability margins of the various internal feed-back loops of the system as well as of the overall system with and without automatic power and temperature controls are analyzed by frequency response techniques. The reactor core is treated as a distributed system for the heat transfer representation by allowing reactor power, neutron flux, fuel plate temperature and organic temperatures to vary in time and one-dimensional space. The temperature coefficients of reactivity of the coolant and moderator are considered. The heat exchanger and pneumatic temperature controller dynamics are discussed in detail as a separate system, then coupled to the reactor core. The on–off power level control system effect on stability is analyzed by describing function techniques. The equations used for an analog computer study of the overall system transient response are presented. The transient responses of the system variables are presented and discussed. Recommendations aimed at improving overall system performance are given. (auth)

2580 (IDO-16793) AN ANALYSIS OF THE INHERENT STABILITY OF THE EOCR. S. R. Gossmann (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Aug. 24, 1962. Contract AT(10-1)-205. 69p.

The inherent stability of the EOCR at full power, exclusive of the heat exchanger, is investigated. Space and time dependent differential equations and transfer functions for the nuclear and thermal processes occurring in the reactor core and vessel are derived. Reactor stability is analyzed by application of the Nyquist stability criterion. The results show that the EOCR has an extremely large margin of inherent stability. (auth)

2581 (KR-25) ANALYSIS OF BOILING REACTOR TRANSIENTS FOR THE ASSESSMENT OF REACTIVITY COEFFICIENTS. Jan Husebye and Olov Nylund (Norway. Institutt for Atomenergi, Kjeller). June 1962. 83p.

Oscillation measurements performed on the HBWR, 1st charge, were correlated with a theoretical model for small reactor transients to assess reactivity coefficients at operating conditions. From the results it was found that the fuel temperature coefficient is about 1.5 pcm/°C, the void coefficient is 0.048% per % void in fuel channels, and the moderator temperature coefficient is about 40 pcm/°C. The HBWR-1 reactor has a rather low steam void content in the core at operating conditions. Therefore, the reactor is stable, and its dynamic behavior is governed mainly by slow effects such as temperature changes of the moderator. This influenced to some extent the construction of the mathematical model. Although the model is generally applicable to boiling water reactors, it should not be used directly for extremely slow or for fast reactor transients. (auth)

2582 (LAMS-2782) STATUS REPORT ON ULTRA HIGH TEMPERATURE REACTOR EXPERIMENT (UHTREX) FOR FOUR-MONTH PERIOD ENDING SEPTEMBER 20, 1962. (Los Alamos Scientific Lab., N. Mex.). Oct. 1962. Contract W-7405-eng-36. 21p.

In reactor development, bids on the pressure vessel were received but not evaluated. Other developmental work is reported on carbon components, fuel loading mechanisms, fuel transfer gas locks, and control rods. A ½ scale model for analyzing flow distribution in the reactor core is being constructed. Progress in development of other cooling system components such as the main heat exchanger, heat recuperator, and He blower is reported along with results of an analysis of the cooling system dynamics. Research and development are also described in the areas of gas cleanup and storage, construction, materials testing, and fuel elements. (J.R.D.)

2583 (NP-12087) FLUID-FLOW STUDIES FOR PREDICTING THE FEASIBILITY OF NUCLEAR-POWERED SUPERSONIC VEHICLES. Final Report. R. W. Dayton, E. T. Armstrong, C. E. Sealander, and W. U. Eberts (Battelle Memorial Inst., Columbus, Ohio). Nov. 1, 1949. Project RAND. 43p.

An analysis of heat transfer in high-power-density reactors is presented. An objective of the analysis is to achieve small coolant pressure losses and low temperature differences in the reactor resulting from the use of folded arrays of plates. Such folded flow reactors are attractive for use where mobility is of prime importance. (J.R.D.)

2584 (ORO-586(Vol.I)) EXPERIMENTAL GAS COOLED REACTOR. FINAL HAZARDS SUMMARY REPORT. VOLUME I. DESCRIPTION AND HAZARDS EVALUATION. (Kaiser Engineers. Div. of Henry J. Kaiser Co., Oakland, Calif.; Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.; Oak Ridge National Lab., Tenn.; Tennessee Valley Authority, Oak Ridge, Tenn.; and Oak Ridge Operations Office, AEC). Oct. 10, 1962. Issued in two books.

A detailed plant description including layout drawings is presented. The results obtained in analysis of credible accidents and the associated hazards are also given. (J.R.D.)

2585 (TID-17199) THE VALUE OF PLUTONIUM IN FAST REACTORS. Leonard E. Link (Argonne National Lab., Ill.). Aug. 1962. Contract [W-31-109-eng-38]. 27p. (UAC-6821)

The plutonium value calculations are made by equating the variable costs in a given reactor fueled with uranium-235 with the same category of costs in the same reactor operated in an identical manner except that it is fueled with plutonium. A plutonium-fueled reactor in the small sizes studied generated 4% more overall power than did its uranium-235 counterpart owing to the more rapid rate of plutonium production in the blanket. The plutonium production and core burnup are calculated from the material balances by the CYCLE code. An exact or narrow range of values for plutonium is not reasonable to state unless some conditions such as neutron spectrum, inventory quantity, and inventory charge rate are established. Without such conditions being set, the value of plutonium will vary. For example, it will decrease as neutron spectrum softens and inventory quantity and charge rate increase. (N.W.R.)

2586 (URCL-6863) THE LRL ADVANCED REACTORS STUDIES PROGRAM—A REVIEW. Robert Fox (California. Univ., Livermore. Lawrence Radiation Lab.). Apr. 3, 1962. Contract W-7405-eng-48. 62p.

The Advanced Reactors Studies program of the Lawrence Radiation Laboratory is reviewed. The review encompasses the origins, progress to date, philosophy underlying the program, and future plans. The basic purpose of the program is the advancement of the technology which is required to achieve the ultimate potential of high-temperature, gas-cooled power reactors. In order that the results may be useful to current development programs as well as future ones, essentially all the work is basic in nature rather than being oriented directly at a specific

concept. The work encompasses four basic areas: materials studies at elevated temperatures; criticality studies; reactor lifetime calculations; and cross-section measurements. The first two comprise about 80% of the total effort. More specifically, the materials studies were concerned with vaporization studies on refractory carbides and diffusion studies using pyrographite. These are being extended. The criticality studies included room-temperature studies on the Th–U–C system and studies over the temperature range 70 to 1200°F on the U–C system. Work is now in progress on a two-temperature assembly. An 18-energy group, multiregion, time-dependent reactivity lifetime calculation was developed which treats all fission product mass chains individually. (auth)

2587 (UCRL-7036(Pt.8)) PLUTO REACTOR TEST FACILITY—SITE 401. PART 8 OF THE TORY II-C PROGRAM. William C. Miller (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 5, 1962. Contract W-7405-eng-48. 32p.

A description of the Pluto reactor test facility is presented in 3 parts: site description, test air system, and air system operations. The function areas, building layout, and associated activities are described in the first part. In the second part the air system and its performance requirements are described. In the third part a chronological sequence of events that are performed when a reactor is tested is presented. (M.C.G.)

2588 (WCAP-6052) YANKEE CORE EVALUATION PROGRAM QUARTERLY PROGRESS REPORT FOR THE PERIOD JUNE 20, 1962 TO SEPTEMBER 30, 1962. (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Oct. 26, 1962. Contract AT(30-1)-3017. 90p.

Initiation of work on this program was authorized on June 20, 1962. A bar graph representing the overall schedule of the program is presented and it is noted that the limiting item on this schedule concerns the design, procurement, and obtaining approvals related to hazards of casks for shipping irradiated fuel assemblies and control rods. Details of the program work are given in sections on transportation of fuel and control rods, fuel assembly examination, control rod examination, and core performance evaluations in the areas of chemistry, metallurgy, engineering, and physics. (J.R.D.)

2589 PRESENT STATE OF NUCLEAR ENERGY. Yves Sousselier. Energie Nucl., 4: 253-9(July-Aug. 1962). (In French)

A résumé of the evolution of energy production by nuclear reactors since 1959 showed the favorable prospects offered by this energy source. The technical improvements made and the principal realizations are reviewed. In conclusion, the present reactor programs are discussed. (auth)

2590 NUCLEAR REACTORS ESPECIALLY FOR ENERGY PRODUCTION. M. Steenbeck. German Patent DWP 20446. Dec. 10, 1960. Kernenergie, 5: 584(July 1962). (In German)

In order to increase the burn-up in fuel elements and to keep the power density over its entire cross section as constant as possible, the center of the reactor, especially pressurized-water heterogeneous reactors, is kept free of fuel elements. The diameter of the free space in the center of the reactor can be between 7 and 30% of the diameter of the fission zone, and the space free of fuel elements can be filled, for example, with pure graphite or natural uranium. (J.S.R.)

2591 NUCLEAR REACTOR. G. Helmis. German Patent DWP 21079. Apr. 10, 1961. Kernenergie, 5: 583 (July 1962). (In German)

Reactors, especially power reactors, were improved with essentially non-solid fuel elements (fissionable material and filler material). In the utilization of fuel slurries, solutions, or suspensions, one or several pistons are correlated in a cylindrical zone and are used to move the fuel. Several pistons can be arranged concentrically and operated in different ways. The pressure system was regulated outside the fission zone and furnished with check valves. (J.S.R.)

2592 METHOD FOR THE COMPARISON OF THE POWER DENSITY IN REACTORS, ESPECIALLY BOILING REACTORS AND BOILING WATER REACTORS. K. Meyer and W. Schimmel. German Patent DWP 21667. Aug. 22, 1961. Kernenergie, 5: 583(July 1962). (In German)

In reactors the power densities vary greatly from locality to locality. Therefore an undesired irregular burn-up of the fuel occurs, so that the fuel is not sufficiently used and economy is reduced. This fault is avoided when, by the use of spongy fuel elements, the medium is so conveyed that a comparison of the power densities is obtainable by the type of fuel removal, and/or by the flow density and/or by the flow velocity. Therefore the fuel sponge was led through the region of various hard neutron spectra, and the hard neutron spectra are alternated with a region of soft neutron spectra. As moderator it was recommended that organic materials or mixtures of known types be used which would also be used for thermal control–especially cooling. (J.S.R.)

2593 FIT OF YANKEE STARTUP EXPERIMENT DATA TO A SIMPLE REACTOR ANALYSIS MODEL. Wm. Howard Arnold, Jr. (Nuclear Utility Services, Inc., Washington, D. C.). Nucl. Sci. Eng., 14: 144-52(Oct. 1962).

A one-group, bare reactor diffusion theory model was applied to data from the startup experiments performed on the Yankee reactor. These data include differential banked control rod worths at various bank heights, the critical balance being maintained by varying concentrations of boric acid, and differential boron worth. The results show an excellent fit to the hot (514°F) data, yielding M^2, k_∞, k_{eff}, and the shutdown k with high precision. The 100°F data did not show such good agreement, probably due to the narrower range of boron concentrations which could be employed at that temperature. (auth)

2594 THE SODIUM-GRAPHITE REACTOR. PART II. Glen W. Wensch (U. S. Atomic Energy Commission, Washington. D. C.). Nuclear Eng., 7: 388-92(Oct. 1962.

A general program of reactor and sodium system development is being conducted for USAEC in order to develop sodium-graphite reactor (SGR) technology to the point where plants of 300 and 1000 Mw(e) can be built. Experimental facilities for testing SGR components and for safety studies are described. Plant characteristics and operating data are tabulated for the Hallam plant, and its economics and fuel cycle costs are discussed in detail. The technical potential of the SGR is discussed, and costs and operating data are tabulated for the projected 300- and 1000-Mw(e) plants. (D.L.C.)

2595 THE SAXTON EXPERIMENTAL POWER REACTOR. E. U. Powell (Westinghouse Electric Co., Pittsburgh), D. E. Hetrick, and James N. Kilpatrick. Nuclear Eng., 7: 393-7(Oct. 1962).

A description is presented of the Saxton power reactor, a 4-Mw(e) pressurized-water reactor for experimental studies of nuclear power generation. Among the items discussed are the containment vessel, buildings, coal-fired plant, reactor system and its unique features, reactor vessel, heat transport, and in-core instrumentation. The experimental program is discussed. (D.L.C.)

2596 NUCLEAR POWER DEMONSTRATION REACTOR. Nuclear Eng., 7: 398-406(Oct. 1962).

A detailed design description is presented of the NPD reactor, a 20-Mw(e) (gross) heavy-water natural-uranium reactor for demonstrating the feasibility of power generation with reactors of this type. Criticality was first attained on April 11, 1962, and full power generation was achieved on June 28, 1962. (D.L.C.)

2597 COMMISSIONING KAHL'S 15 MW BWR. R. Kuehnel and R. Misenta. Nuclear Eng., 7: 407-14(Oct. 1962).

Results are given for zero-power and power operation tests of the Kahl boiling water reactor. The zero-power tests included temperature coefficients, void coefficients, control rod calibration, and fine structure of the flux. The power operation tests included temperature control, control rod drive, dynamic behavior, etc. (D.L.C.)

2598 YANKEE CORE I PERFORMANCE. R. J. Coe (Yankee Atomic Electric Co., Boston) and R. J. Creagan. Westinghouse Eng., 22: 130-5(Nov. 1962).

The Yankee power reactor achieved its first criticality on Core I on August 19, 1960, and on May 18, 1962, the reactor was scrammed after 1,229,105,000 kwh had been delivered to the transmission system. The operating record and technical performance during this period are reviewed and further improvements suggested. Among the items discussed are primary loop components, reactor core, main coolant chemistry, radiation and shielding, and economics. The overall performance was outstanding, and a 90% capacity factor now seems possible. A two-year evaluation program will be conducted on Core I. (D.L.C.)

2599 PROCEEDINGS OF U.S.-JAPAN ATOMIC INDUSTRIAL FORUMS JOINT CONFERENCE ON NUCLEAR POWER, TOKYO, DEC. 5–DEC. 8, 1961. (Atomic Industrial Forum, Inc., New York and Tokyo. Japan Atomic Industrial Forum, Inc.). Dec. 1961. 295p. $10.00.

Papers were given concerning: atomic energy development; power reactor design, construction, development, and operating experience; nuclear maritime propulsion; financing of nuclear power; fuel-cycle aspects of nuclear power; and requirements for inter-industry, industry-government, and international cooperation and relations in the field of nuclear power. A total of 44 papers was presented, all in English. (T.F.H.)

2600 PRELIMINARY DESIGN OF A POWER GENERATING SYSTEM USING A FISSILE GAS. Agust Valfells. Thesis, Ames, Iowa State Univ. of Science and Tech., 1962. 159p.

A preliminary study was made of a system that utilizes a fissile gas, thermally ionized by its own fission, for electric power generation by magnetohydrodynamic means. Enriched uranium tetrafluoride is proposed as the fuel in a gas-phase thermal fission reactor that operates at a temperature of around 3000°K. The core consists of an array of gas ducts in a graphite matrix. Fission takes place in the gas as it is pumped through the ducts in the graphite moderator, giving rise to partial thermal ionization of the gas. To further promote ionization, the fuel is laced with cesium fluoride. After heating in the core under a pressure of 100 atm, the gas is expanded through a nozzle into a magnetohydrodynamic generator, where part of the kinetic energy of the gas jet is converted into electrical energy. Subsequently, the gas is cooled in a heat exchanger and recompressed prior to recirculation back to the core. A small amount of gas is continuously bled off for fission product removal and reprocessing. A corresponding amount of fresh uranium tetrafluoride is added as makeup gas. The study indicates that the cost of electricity from a 300 Mw(e) plant operating in this manner might be comparable to that of power from more conventional nuclear power plants. (Dissertation Abstr., 23: No. 3, 1962)

2601 POWER REACTOR TECHNOLOGY. Volume 5, No. 4, Walter H. Zinn (General Nuclear Engineering Corp., Dunedin, Fla.). Sept. 1962. 100p. (GPO) $0.55 (domestic), $0.70 (foreign). (One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC).

A review of reactor development is presented. The economics of D_2O production is discussed along with the new prices of U and Pu recycle technology. Other sections are devoted to the examination of developments in reactor physics, heat transfer, shielding, iodine leakage and disposal, reactor materials, and radiation effects and radioactivity. Information is also included on the design of the Piqua power facility, operating experience at Shippingport, development of Na- and gas-cooled reactors, technology concerning the spectral shift reactor, and power-reactor experiments. (J.R.D.)

2602 IMPROVEMENTS IN OR RELATING TO STEAM GENERATING PLANT. Stefan George Bauer and Derek Howard Jubb (to Rolls-Royce Ltd.). British Patent 907,708. Oct. 10, 1962.

A nuclear power plant is designed using a heavy-water-moderated, steam-cooled reactor. In this plant, feed water is heated by the moderator and reactor steam to form feed steam, which is then superheated by superheated reactor steam and expanded through a nozzle. The feed steam issuing from the nozzle has added to it the superheated reactor steam, and the resulting steam is compressed, heated further in the reactor, and part of it passed to the turbine. (D.L.C.)

2603 MERCHANT MARINE SHIP REACTOR. (to U. S. Atomic Energy Commission). British Patent 907,816. Oct. 10, 1962.

A pressurized water reactor is designed for use in merchant marine vessels. The reactor is of compact construction by virtue of a novel multi-pass core design, and its reactivity lifetime is conservatively estimated at 52,275 Mwd or 3.33 calendar years of operation without fueling. The fuel elements are square in cross section and are confined within an egg-crate type lattice. (D.L.C.)

2604 HIGH TEMPERATURE NUCLEAR REACTOR. (to Brown, Boveri and Cie, Aktiengesellschaft and Beteilgungs-und Patentverwaltungsgesellschaft Mit Beschränkter Haftung). British Patent 908,404. Oct. 17, 1962.

A high-temperature power reactor cooled by gas is designed with means for avoiding the need for auxiliary sources of energy for starting the gas turbine. The reactor is provided with a second circuit fed with water, and the resulting steam may be used to start the gas turbine. This reactor is especially suited for use on ships where weight and space are at a premium. (D.L.C.)

2605 IMPROVEMENTS RELATING TO THE PRODUCTION OF ELECTRICAL ENERGY FROM ATOMIC NUCLEAR REACTIONS. Manfred Siebker. British Patent 908,469. Oct. 17, 1962.

A method for the efficient production of electric energy from reactors is given. In this method, the reactor heat is used to dissociate thermally the working medium, the dissociation products are separated from one another, and the chemical energy thus obtained is converted into electric energy by means of chemical fuel cells. Nuclear power plants using steam and H_2-O_2 chemical fuel cells are de-

scribed in detail; the efficiency is expected to be 69%. (D.L.C.)

2606 NUCLEAR POWER PLANTS. (to Sulzer Frères). British Patent 908,925. Oct. 24, 1962.

A nuclear power plant for generating superheated steam is designed in which the required blower power is reduced considerably. In this plant, the reactor is cooled by wet steam, and the steam leaving the reactor is divided into two streams, one stream acting as working medium for a turbine and subsequently condensed, while the second stream is cooled by the condensed first stream and circulated by a blower. The condensed first stream is mixed with the second stream downstream of the blower. (D.L.C.)

2607 IMPROVEMENTS IN OR RELATING TO STEAM GENERATING PLANT. Stefan George Bauer (to Rolls-Royce Ltd.). British Patent 908,991. Oct. 24, 1962.

A nuclear power plant is designed in which superheated steam from the reactor is used to evaporate the feed water. The plant comprises a reactor, a primary evaporator wherein feed water is evaporated by superheated steam on its way to the turbine, and a plurality of secondary evaporators wherein water is sprayed into superheated steam. The evaporators are connected with the reactor in a way so that steam generated in the primary evaporator is superheated in the reactor and passed through the secondary evaporators in succession, the steam leaving each secondary evaporator being superheated in the reactor before going to the next evaporator. The steam leaving the last evaporator is finally superheated and passed through a coil in the primary evaporator and on to the turbine. (D.L.C.)

2608 GRAPHITE-MODERATED GAS-COOLED NUCLEAR FISSION REACTOR. Dennis W. Ginns and Harold H. Gott (to Atomic Energy of Canada Ltd.). Canadian Patent 647,410. Aug. 28, 1962.

A reactor is designed for a high rate of heat transfer for power generation. The cooling channels are arranged horizontally, and inlet and outlet headers are provided across the core between its opposite faces so that coolant enters the channels near the center of the core where the neutron flux is greatest. The fuel elements are finned for increased heat transfer. (D.L.C.)

2609 IMPROVEMENTS RELATING TO LOCKING ARRANGEMENTS FOR NUCLEAR REACTOR FUEL ELEMENTS. Graham Coates and Terence Graham Bryant (to A.E.I.-John Thompson Nuclear Energy Co. Ltd.). U. S. Patent 3,057,793. Oct. 9, 1962.

A fuel element-locking arrangement is designed for a boiling-water reactor which is to be used for ship propulsion. The arrangement comprises horizontal rods arranged in rows in the lower part of the reactor for engaging the annular recesses in the lower ends of the fuel elements. The rods are also recessed at intervals, and when it is desired to release the fuel elements, the rods are moved axially so that their recesses are aligned with the recesses in the fuel elements. (D.L.C.)

2610 REACTOR. Charles M. Slack and Walter G. Roman (to Westinghouse Electric Corp.). U. S. Patent 3,058,897. Oct. 16, 1962.

A fluidized pellet-bed reactor is designed for power production. The moderator-coolant flow controls the fission process by controlling the geometric pattern of the pellets, and in event of pump failure, the pellets will collapse into a noncritical position. Storage chambers for new and used pellets are provided with hydraulic means for transporting the pellets between the chambers and the reactor vessel. The advantages of this reactor over other reactor types are discussed. (D.L.C.)

2611 NUCLEAR REACTORS. Henry R. C. Pratt (to United Kingdom Atomic Energy Authority). U. S. Patent 3,058,898. Oct. 16, 1962.

A boiling reactor of the liquid-moderated, calandria type is designed in which the steam voidage in the core is constant, thereby giving a constant power level. In the core, fuel rods are arranged in coolant tubes to define annular spaces for the coolant flow, and the coolant is fed to the spaces at such a pressure head and feed rate that a climbing film system is set up. (D.L.C.)

Production Reactors

2612 (ANL-6614) EXPERIMENTAL BREEDER REACTOR-II (EBR-II) SHIELD DESIGN. M. Grotenhuis (International Inst. of Nuclear Science and Engineering, Argonne, Ill.); A. E. McArthy, and A. D. Rossin (Argonne National Lab., Ill.). Sept. 1962. Contract W-31-109-eng-38. 49p.

A description of the EBR-II shield and the methods employed in arriving at the final design are presented. The major shield design problems for that reactor are enumerated and discussed. (auth)

2613 (HW-71137) PROTECTION AND CLEANING OF NPR WATER AND STEAM PIPING SYSTEMS PRIOR TO OPERATION. W. D. Bainard and E. M. Kratz (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 10, 1962. Contract AT(45-1)-1350. 26p.

Acceptable degrees of cleanliness for the NPR water and steam piping systems are defined. Methods used to attain and maintain this cleanliness and to provide adequate corrosion protection are described. The primary, secondary, graphite-cooling, raw-water, sewer and waste-drain, and other water and steam systems are discussed. (M.C.G.)

2614 (HW-74422) LONGEVITY EFFECTS OF HIGH TANK DISCHARGE LINE DESCALING. Harry F. Jensen (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 26, 1962. Contract AT(45-1)-1350. 4p.

Periodic inspections were made following the chemical descaling of the B, C, D, DR, F, and H high tank discharge lines. Photographs are presented for comparison of the original condition with that immediately after descaling and one year after the operation. (J.R.D.)

2615 (HW-SA-2017) MASS PRODUCTION MAINTENANCE. R. C. Theil (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Oct. 10, 1960. Contract [AT(45-1)-1350]. 17p.

The advantages of mass production maintenance as demonstrated in replacement of the hot face gas seals in the KW and KE reactors are reported. During the 105-KW job an approach to seal replacement was developed which greatly simplified the task. Other, less obvious, but important lessons were likewise learned. By study of these improved methods, great savings of time and money were made in similar operations on the KE-reactor. A description of the advantages gained in the KW experience is given. (J.R.D.)

2616 HOMOGENEOUS BREEDER NUCLEAR REACTOR. Olle Lindstroem (to Allmänna Svenska Elektriska Aktiebolaget). Canadian Patent 648,849. Sept. 18, 1962.

A homogeneous breeder reactor with a two-zone system is designed which retains all the advantages of a one-zone reactor. In the reactor, portions of the fuel and breeder solutions are fed from the respective zones into a mixing chamber and thence to a separating vessel, whereby the mixture is divided into a pure uranyl sulfate solution (fuel)

and a ThO_2 dispersion (breeder), which are passed back to the respective zones. Thus, solid fission and corrosion products are carried from the core zone to the mantle zone, while newly formed fissile material is transferred in the the opposite direction. (D.L.C.)

Research Reactors

2617 (IDO-16806) SPERT PROJECT QUARTERLY TECHNICAL REPORT, APRIL–JUNE 1962. F. Schroeder, ed. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Sept. 21, 1962. Contract AT(10-1)-205. 40p.

Static measurements of various nuclear core parameters were completed for the highly enriched plate-type Al-clad core to be used for the Spert I integral core destructive test program. Self-limiting power excursion tests were performed with initial asymptotic reactor periods in the range of 934 to 4.6 msec to establish the transient response of the core and to obtain data for extrapolation to shorter-period tests in which violent destructive effects are expected. For tests with periods shorter than about 7 msec, fuel plate deformations were produced as a result of thermal stresses in the plates. Melting of fuel plates was obtained in two tests with periods of 5 and 4.6 msec. For tests with periods in the range of 9 to 4.6 msec, power burst shape changes were observed which result in an increase in the ratio of the energy release in the total burst to that at the time of the power peak, as the period is shortened. Maximum transient pressures never exceeded 10 psi for tests thus far performed. A series of self-limiting power excursion tests was initiated in Spert II to determine the effects of the initial system temperature on the kinetic response of the D_2O-moderated expanded core loading. The data indicate that as the initial system temperature is increased to near the saturation temperature, boiling becomes a more predominant shutdown mechanism with a consequent reduction in the peak power, burst energy, and fuel-plate surface-temperature rise. The increased dependence on steam formation for shutdown as subcooling is decreased leads to relatively larger amplitudes for power oscillations following the initial burst. The larger unstable void volumes which are produced is the apparent reason for this occurrence. (auth)

2618 (JUL-50-RE) PHYSIKALISCHE GRUNDLAGEN DES FRJ-2 (DIDO). (Physical Fundamentals for the FRJ-2 (DIDO)). O. Schaffer (Kernforschungsanlage, Jülich, Germany). Mar. 1962. 129p.

Nuclear calculations, temperature distribution studies for stationary reactor operation, perturbation calculations, evaluations of the reactivity influence of the control absorber, and analyses of reactor kinetics are presented. Problems were solved with the help of the two-group diffusion theory. (M.C.G.)

2619 (LADC-5408) PLUTONIUM AS A FUEL FOR THE LOS ALAMOS MOLTEN PLUTONIUM REACTOR EXPERIMENT. D. B. Hall (Los Alamos Scientific Lab., N. Mex.). [1961]. Contract [W-7405-eng-36]. 18p.

Descriptions of LAMPRE I and its operation are presented. It is pointed out that the reactor was designed to provide a testing function and should not be regarded as a prototype design. The description serves as a method of reporting the status of the project. While problems of handling molten Pu are not solved, promising progress toward solution of these is reported. (J.R.D.)

2620 (NARF-61-19R) 3Mw ASTR. J. B. McGuffin, C. W. Dickenson, D. F. Ross, W. T. Kowalewski, and J. T. Pancost (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Aug. 18, 1961. Contract AF33(600)-38946. 287p. (FZK-9-161)

A description of the 3-Mw Aerospace Systems Test Reactor and its associated systems is presented. The design characteristics are described, followed by a description of the special handling tools and their use. The reactor instrumentation and controls, their safety features, their method of operation, calibration, and setup are described. All the hydraulic systems are discussed. The methods used in checking out the reactor from zero power to its design power of 3 Mw are outlined. The subsequent operating experience gained from actual operation of the ASTR in an experimental program is described. (M.C.G.)

2621 (SC-4737(M)) THE SANDIA PULSED REACTOR FACILITY (SPRF). P. D. O'Brien (Sandia Corp., Albuquerque, N. Mex.). Oct. 1962. Contract [AT(29-1)-789]. 42p.

This is a laboratory facility specifically designed for radiation effects experiments which require an intense pulse of fast neutrons and gamma rays. The facility is designed around the Sandia Pulsed Reactor (SPR) and includes four buildings and an outdoor burst site. The instrumentation building adjacent to the reactor building is reserved exclusively for use in radiation effects programs. Outside the reactor building door is the earth-covered beam catcher building, which houses the heating plant, air compressor, and elevator hydraulic system for the reactor building. A concrete shield connects the reactor and beam catcher buildings and attenuates radiation scattered toward the trailer parking area. The reactor control building, located 200 feet from the reactor building, houses the control console from which the SPR is controlled and monitored, as well as office and laboratory space. An outdoor burst site, located 2400 feet southeast of the control building, is provided for experiments which are incompatible with the limitations of the reactor building. Cables between the control building and the outdoor burst site permit the reactor to be operated at ground level or, for maximum freedom from scattering influences, atop a 20-foot tower. (J.R.D.)

2622 (TID-17196) ADVANCED HIGH FLUX RESEARCH REACTOR TECHNOLOGY. C. N. Kelber, B. I. Spinrad, and L. J. Templin (Argonne National Lab., Ill.). July 1962. Contract W-31-109-eng-38. 5p. (UAC-6711)

The development of high-flux research reactors is discussed. The major factor limiting further advance, restricted power density, is described. One method of improvement considered is designing for specific experimental use. Limitations were investigated in a comparative study of H_2O, D_2O, and Na cooled reactors of annular-core type. It is shown that power densities can be increased with techniques suggested for rocket propulsion. Achievement of high fluxes in very dilute, large-core reactors is discussed. (M.C.G.)

2623 THE FIRST JAPANESE SWIMMING-POOL REACTOR (HITACHI TRAINING REACTOR). K. Eto, A. Ohki, S. Matsumoto, and S. Ozaku (Hitachi Ltd., Tokyo). Atompraxis, 8: 351-7(Sept. 1962). (In English)

A general description is given of the Hitachi Training Reactor (HTR), which is the first Japanese-made swimming pool reactor. The HTR is rated at 100 kw with an average in-core thermal neutron flux of 1.4×10^{12} n/cm^2/sec. Elementary specification of the HTR are as follows: Type: Enriched uranium, light water-moderated and cooled swimming pool type; Thermal output: 100 kw; Fuel: 10% enriched ceramic uranium dioxide pellets, fuel load is ap-

proximately 4 kg U^{235}; Cladding: Aluminum; Core size: 40 cm^3; Reflector: Graphite and light water; Coolant: Light water, forced circulation; Experimental facility: a) Pool for shielding experiments, 3 m (W) × 6.5 m (L) × 7.5 m (D); b) Horizontal beam part, 4 × 150 mm ø; c) Horizontal through tube, 1 × 25 mm ø; d) Pneumatic tube, 2 sets; e) Thermal column, 1 set; f) Isotope production rack, 1 set; g) Isotope train, 1 set. The reactor is noteworthy for the following reasons: 1. The reactor was planned, designed, and manufactured entirely in Japan by Hitachi, Ltd. The only foreign thing is the UO_2 powder leased from the USAEC because of its enrichment. 2. Pellet-type uranium dioxide fuel is employed in the research reactor, which has resulted in various advantages for the reactor. 3. The reactor tank is separated from the experimental pool, giving greater ease of operation. 4. Emphasis is placed on the safety and reliability of the reactor, such as the incorporation of a two-out-of-three circuit in the safety system. The HTR went critical on Dec. 25, 1961, with 2.6 kg of U^{235}, and has operated successfully since then. (auth)

2624 THE ORGANIZATION FOR THE CONTROL OF THE ULYSSE REACTOR AT SACLAY. André Baude. Energie Nucl., 4: 266-77(July-Aug. 1962). (In French)

After a review of the particular features of the Ulysse reactor necessitated by its training purposes, the control of the reactor is briefly described. The safety devices and precautions are considered in some detail. (auth)

2625 REACTOR INSTALLATIONS. H. Schelle and O. Heise. German Patent DWP 20977. Mar. 4, 1961. Kernenergie, 5: 583(July 1962). (In German)

In reactor installations with gas-cooled or steam-producing reactors, especially research reactors, research carried out in coolant channels can be improved if a definite channel to which is led the coolant leaving the reactor, is provided for research. The coolant current can be discharged through a nozzle into the channel which can be provided with a radiation-absorbing jacket. (J.S.R.)

2626 IMPROVEMENTS RELATING TO BEAM TUBES FOR NUCLEAR REACTORS. Brian Frederick Cooke (to A.E.I.-John Thompson Nuclear Energy Co. Ltd.). British Patent 908,445. Oct. 17, 1962.

A beam tube arrangement is designed which can be sealed to prevent escape of radiation. The beam tube is provided with a shielding door arranged to be moved on rails laterally across the outer end of the tube and having a closure plate mounted on linkages. In sealing the beam tube, the plate is rotated about the linkages and forced against a seating around the end of the beam tube to make a liquid-tight seal. Means is provided for filling the interior of the beam tube with water. (D.L.C.)

SPACE APPLICATIONS AND TECHNOLOGY

2627 (MND-P-2483-7) SNAP 7 PROGRAM — TASK 8 — STRONTIUM-90 FUELED THERMOELECTRIC GENERATOR DEVELOPMENT. Quarterly Progress Report No. 7, May 1 through July 31, 1962. W. A. McDonald (Martin-Marietta Corp. Aerospace Div., Baltimore). Contract AT(30-3)-217. 20p.

The effort on SNAP 7A and 7C was confined to operating the reliability model. There were fluctuations in output power that can be attributed to variations in the operating parameters, plus an increase in the internal resistance. In the SNAP 7B project the second 60-watt generator was completed and has undergone the beginning-of-life (maximum input, helium gas) portion of the parametric tests. The performance was nearly identical to that of the first 60-watt generator. The unit will be used with the SNAP 7B system. The installation concept for the SNAP 7B system was approved by the U. S. Coast Guard. The generator is to be housed in a finned aluminum container that will provide the required radiator surface. This container will be filled with a water-ethylene glycol mixture that is necessary to transfer the heat from the generator into the container. The battery-converter compartment is an integral part of the container lid. During the time the entire SNAP 7D system was subjected to shock and vibration tests, no mechanical or functional deficiencies were detected. The required temperature tests followed the mechanical tests. During this period the complete system was operated at maximum intermediate and minimum temperatures. Design objectives were satisfied throughout the test. The SNAP 7D generator was fueled at Oak Ridge National Laboratory (ORNL) on June 12, 1962, with a total thermal input of 1435 watts. The fueled generator was returned and integrated with the system. The system was demonstrated and accepted on July 3, 1962. (auth)

2628 (TID-17210) RADIATION DAMAGE TO SATELLITE ELECTRONIC SYSTEMS. [S. C. Rogers] (Sandia Corp., Albuquerque, N. Mex.). [Oct. 1962]. Contract [AT(29-1)-789]. 29p. (SCDC-2843)

The radiation sensitivity of satellite electronic systems was examined in order to determine the limitations they place on satellite life. The effects of radiation on components are briefly reviewed. Methods are presented and illustrated for determining the minimum radiation level at which circuit failure could occur. The effects of shielding on the radiation belt levels are discussed. It is shown that the effects of space radiation on satellite circuits, in general, can be made negligible by using good design practices. (M.C.G.)

2629 DESIGNING FOR SPACE RADIATION. Sidney Russak. Aerospace Eng., 21: No. 10, 60-1; 79; 81-2(Oct. 1962).

The inherent shielding offered by spacecraft is considered. Proton doses from a class 3+ solar flare within two different re-entry vehicle versions of the same lunar spacecraft were calculated to be 1,306 and 397 rad, respectively, as compared with a dose of 18,099 rad for an unprotected man. The command module equipment would reduce further these doses to 130 and 75 rad, and other possible ways of dose reduction are discussed. (D.L.C.)

2630 DYNAMIC ENGINES FOR SPACE POWER SYSTEMS. Victor P. Kovacik (Thompson Ramo Wooldridge Inc., Cleveland). ARS (Am. Rocket Soc.) J., 32: 1511-22 (Oct. 1962).

A review of dynamic energy conversion systems is presented with an overall perspective of the current state of the art. The dynamic engine concepts treated include both open and closed cycle systems, and their current development status is reviewed. Future areas of research and development and performance are also discussed. (D.L.C.)

2631 APPLICATION OF THE WAVE SUPERHEATER TO NUCLEAR ROCKETS. George M. Saad and William Squire (West Virginia Univ., Morgantown, W. Va.). ARS (Am. Rocket Soc.) J., 32: 1597-9(Oct. 1962).

Some possible applications in nuclear rocket systems are considered for the wave superheater, which involves using shock waves to produce very hot gases. The use of a wave superheater with solid core reactors is found to result in only small increases in specific impulses for steam driving hydrogen and steam driving steam. The gaseous fission reactor, in which the superheater could be used to conserve the uranium, is discussed briefly. (D.L.C.)

2632 THE PLASMA PINCH PROPELLER. Rev. Gen. Electron., 16: No. 186, 40-6(May 1962). (In French)

Work being done at Republic Aviation on plasma pinch propulsion is briefly reviewed. Space engines, plasma pinch processes, and the XE-1 propeller are described. (J.S.R.)

2633 "GULLIVER" — A QUEST FOR LIFE ON MARS. Gilbert V. Levin, Allen H. Heim, John R. Clendenning, and Mary-Frances Thompson (Resources Research, Inc., Washington, D. C.). Science, 138: 114-21(Oct. 12, 1962).

The conditions and features to be expected on Mars are described. Reasons are given for the decision to test the Mars environment for microorganisms of aqueous and carbonaceous nature. Experimental considerations involved in sending a life probe to Mars are discussed. Gulliver, a probe for detecting evolved radioactive gases from labeled substrates metabolized by microorganisms, are tentatively selected to be included in the first capsule to be sent to Mars. The development and testing of the probe are described in detail. The possible significance of the probe experiment is discussed. (D.L.C.)

2634 DESIGN PARAMETERS FOR PHOTOVOLTAIC POWER CONVERSION IN SPACE. K. A. Ray (Hoffman Electronics Corp., El Monte, Calif.). Preprint Paper No. CP 62-1202. New York, American Institute of Electrical Engineers, 1962. 15p. $1.00.

Design parameters, such as current, voltage, temperature, and intensity relations for silicon solar cells are listed. The relation of these parameters to the basic photovoltaic theory is given. Methods for establishing the parameters are described. The solar cell physical characteristics are listed, and their interactions with the mounting substrates are discussed. Typical solar cell panel configuration is described. The thermal balance problem in such a system is defined. Typical thermal characteristics, such as emissivity and absorptivity, are given. The "state of the art" is given for power and weight figure-of-merit for space power conversion. (auth)

2635 NUCLEAR REACTOR SPACE POWER SYSTEMS. J. R. Wetch and M. G. Coombs (Atomics International, Canoga Park, Calif.). Preprint Paper No. CP 62-1203. New York, American Institute of Electrical Engineers, 1962. 13p. $1.00.

The status of the space reactor program is reviewed. The SNAP 10A, a 500-watt thermoelectric system; the SNAP 2, a 3-kw mercury turboelectric system; and the

SNAP 8, a 30-kw scale-up of the SNAP 2 system are described. Factors that influence the design of a nuclear space power system are presented, and the prospects for future higher power nuclear systems are discussed. (auth)

2636 SPACE RADIATOR ANALYSIS AND DESIGN. D. B. Mackay (Space and Information Systems Div., North American Aviation, Inc.). Preprint Paper No. 62-1204. New York, American Institute of Electrical Engineers, 1962. 34p. $1.00.

Methods are given for determining the sizes of radiation heat exchangers and exchanger elements. Data are given pertaining to the computation of radiation heat transfer from a variety of extended surface configurations. Both plain-duct and extended-surface exchangers are evaluated. For each type of exchanger, two cases are studied, viz. that in which heat is lost from a single side of the exchanger and that in which heat is lost from both sides of the exchanger. Environmental effects on heat transfer are included in the analyses. (auth)

2637 RADIOISOTOPE POWER SYSTEM OPERATION IN THE TRANSIT SATELLITE. P. J. Dick (Martin Marietta Corp., Baltimore) and R. E. Davis. Preprint Paper No. CP 62-1173. New York, American Institute of Electrical engineers, 1962. 11p. $1.00.

Day-to-day telemetry readout of stabilized radioisotope-powered generator load voltage from the Transit 4B satellite shows that early thermoelectric system mortality does not occur and that sun-to-shade generator surface temperature variations are about 40°F. The application of a closely matched, input-regulated, step-up voltage converter in conjunction with the radioisotope power supply (RIPS) also shows that multiple voltages can be supplied to the electronic packages while maintaining conversion efficiencies in the range of 70 to 85%. By use of converter output filters, voltage ripple can be held below 0.5% and radiofrequency interference is essentially eliminated. (auth)

2638 AN ION ENGINE SYSTEM FOR FLIGHT TESTING. G. R. Brewer and G. A. Work (Hughes Aircraft Co., Malibu, Calif.). Preprint Paper No. CP 62-1162. New York, American Institute of Electrical Engineers, 1962. 18p. $1.00.

A qualitative study is presented of some of the critical problems associated with the flight testing of ion engines from the point of view of the total test system, i.e., the ion engine, power supply, instrumentation, test vehicle, etc. An attempt is made to show relations between various components of the test system and to describe the effect of space testing requirements on the type of flight system used. In presenting the problems of an electrical propulsion test system, a specific system is described that uses a Scout-type launch vehicle. An ion propulsion engine, and its various components and principle of operation are described. Tests are discussed that are necessary to evaluate engine performance, dividing these tests into those which can be conducted on the ground and those which require space flights. Other components of the test system, and their relations and dependence on the electrical propulsion test requirements, are also studied. (auth)

WASTE DISPOSAL AND PROCESSING

Refer also to abstracts 1177, 1655, and 1656.

2639 (DPSPU-62-30-21B) LITHOLOGY AND HYDROLOGY OF RADIOACTIVE WASTE DISPOSAL SITES AT THE SAVANNAH RIVER PLANT. S. O. Reichert and J. W. Fenimore (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.). Oct. 1962. Contract AT(07-2)-1. 37p.

The techniques used to determine and map the lithology, structure, and hydrology of the Savannah River Plant areas for waste disposal are examined. Results obtained using these techniques, and conclusions concerning the radiological safety attained are discussed. (J.R.D.)

2640 (HW-74371) LABORATORY STUDIES ON IN-TANK CONCENTRATION OF COATING REMOVAL WASTE. J. E. Mendel (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Aug. 6, 1962. Contract AT(45-1)-1350. 20p.

Laboratory investigations directed toward obtaining information on the solidification characteristics of radioactive wastes as a function of temperature and concentration are described. The data which are included refer to coating removal waste. Results indicate that solidified coating wastes, when cooled completely, will absorb water at atmospheric conditions which can occur at Hanford. It appears however, that the quantity of water which must be absorbed to form a liquid phase is so large that this occurrence is unlikely. (J.R.D.)

2641 (HW-SA-2748) EVALUATION OF DISCHARGING RADIOACTIVE WASTES INTO FRESH WATER STREAMS. R. B. Hall and R. H. Wilson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [Oct. 16, 1962]. Contract AT(45-1)-1350. 19p.

Radioactive waste releases in fresh water streams are evaluated against national standards of human radiation dosage. The principal mechanisms of exposure from such releases are through drinking water, fish, irrigated crops, and recreational use of the waste containing streams. Each of these potential sources is evaluated downstream from the Hanford reactors. (J.R.D.)

2642 (KT-530) EVAPORATION OF RADIOACTIVE WASTE SOLUTIONS. J. C. McClymont, Jr., W. R. Alcorn, and J. A. Lauber, Jr. (Massachusetts Inst. of Tech., Oak Ridge, Tenn. Engineering Practice School). May 3, 1960. Contract W-7405-eng-26. 20p.

The capacity of existing storage facilities for radioactive waste will be exceeded as quantities of radioactive waste solutions are increased by expanding process and development work in the field. One method of dealing with this problem is to concentrate the radioactive waste solutions by evaporation. Two evaporator systems were proposed to do the job: an evaporator system with an external heating unit and an evaporator with an internal heating unit. From past experience it is anticipated that two problems will arise in production size evaporators: scale formation on heating surfaces and excessive foaming in the evaporators. A study was undertaken to determine which of two proposed systems would be most suitable for dealing with the anticipated problems. Simulated radiochemical waste solutions (without radioactive constituents) were evaporated to various concentrations in bench-scale models of the two proposed evaporator systems. The effects of three variables on rate of heat transfer were investigated: increase of boiling point with increased concentration, scale formation, and increase in the amount of solids in suspension and solution with increased temperature. No scale formation or foaming was detected in either of the bench-scale evaporator systems. A decrease in heat transfer rate of 60% was found in going to a volume reduction ratio of 16:1 using the external heating unit. It was concluded that 40% of the decrease was due to the increase in boiling point with increased temperature plus the decrease of the over-all heat transfer coefficient with decreased temperature gradient. The remaining 20% was attributed to the increase of solids in solution and suspension as the solution was concentrated. Because a higher over-all heat transfer coefficient was obtained, it was concluded that the internal heating unit evaporator assembly was more effective in evaporating the simulated waste solution. It is recommended that the bench-scale systems be run with actual radiochemical waste solutions for prolonged periods (36 to 48 hours) to determine which system is most suitable in dealing with foam and/or scale formation under these conditions. It is also recommended that the internal heating unit be used with a wire mesh or screen in the top section of the evaporator to aid in reducing any foaming which might occur. (auth)

2643 (UCRL-13048) STUDIES OF THE MIGRATION OF RADIOISOTOPES IN HOMOGENEOUS VERTICAL COLUMNS. Second Annual Report. (Cover carries title: INTERIM REPORT ON FESEARCH ON RADIOACTIVE CONTAMINATION OF GROUND-WATER AQUIFERS). (Texas. Agricultural and Mechanical Coll., College Station. Research Foundation and Texas. Agricultural and Mechanical Coll., College Station. Engineering Experiment Station). July 1, 1962. For Univ. of California Lawrence Radiation Lab., Livermore. Contract W-7405-eng-48. 51p.

Several factors affect the transport of radioactive substances by water through granular earth materials. The distribution coefficient is one such factor and measurements of it were made for two mesh sizes of Ottawa quartz sand and microcline. The coefficients for cesium in fine sand and fine microcline ranged respectively from about 0.1 to 8.0, and 3.0 to 41 for a variation in K^+ concentration from 10^{-2} to 10^{-5} molar. The coefficients for Cs^+ vs Ca^{2+} exchange for coarse quartz sand and fine quartz sand ranged respectively between 2.5 and 4, and 7 and 13. The distribution coefficients for Cs^+ vs Ca^{2+} and microcline ranged from 15 to 26 for the coarse sand and 22 to 60 for the fine sand. Exchange column studies were done using quartz sand, quartz, and microcline in two sizes, 20 to 30 and 50 to 60 mesh, and several concentrations of K^+, Na^+, or Ca^{2+} as the carrier or eluting cation. Pulses of cesium and strontium of 10 ml. size were placed on the minerals in lucite columns and eluted at flow rates of 10 or 1 cm per hour. An approximate correlation was possible between the K_d data and the column data. Other factors affecting the movement of radioactivity in granular minerals in columns are as follows: the rate of uptake of the activity by the minerals, the rate of elution of the adsorbed radioactivity, the velocity of the water, hydraulic dispersion, and the chemical nature of the water, minerals, and radioactive substances. All of the aforementioned factors were expressed in a nonlinear differential equation formulated by Joseph E. Knox. A

numerical method is being developed for calculating column histories. (auth)

2644 DESIGN ASPECTS OF THE SAXTON RADIOACTIVE WASTE DISPOSAL FACILITY. E. R. Hottenstein (Gilbert Associates, Inc., Reading, Penna.). Am. Soc. Mech. Engrs., Paper No. 61-WA-224(1961).

Design problems of processing radioactive wastes at a small nuclear site are discussed. Because of a reactor experimental program that is being planned, the influence it has on the design of the facility is also reviewed. Included in the discussion is a description of the liquid-waste storage and processing facilities. Effective decontamination of waste liquids can be achieved by connecting in series a gas stripper and evaporator. Neutralization of boric acid solutions reduced maintenance and improved performance of the evaporator. The installation of a semi-automatic drum-filling and handling system minimized operating personnel exposure but retained sufficient flexibility to permit handling of a wide range of concentrated waste solutions. (P.C.H.)

2645 THE LONG-TERM AVERAGE ATMOSPHERIC DILUTION OF EMISSIONS FROM A CHIMNEY IN THE MOL AREA. J. J. H. Alderhout and H. H. Ph. Moeken (Health and Safety Section, Eurochemic, Mol, Belgium). Intern. J. Air & Water Pollution, 6: 197-9(May-Aug. 1962). (In English)

Calculations were made of the long-term average atmospheric dilution of radioactive material from a stack at the Belgian Atomic Centre, Mol. The annual mean windspeed and the annual mean wind direction frequency was calculated for 36 wind directions from wind data measured at a height of about 25 m. Data on the annual mean direction frequencies over the period from 1931 to 1960 were also used. For each wind direction, the 4 annual mean values, the average for these mean values, and the dilution for each sector was computed. The calculations also show the minimum dilution on the most unfavorable spot. A safety factor was included to ensure the radiation exposure caused by an emission would not exceed the permissible dose levels recommended by the ICRP in 1958. (C.H.)

2646 THE DECONTAMINATION OF RADIOACTIVE LABORATORY WATER. H. Koch and W. Weiland (Institut für Angewandte Radioaktivitat, Leipzig). Isotopen Tech., 2: 215-18(July 1962). (In German)

The processing of radioactively poisoned waste water is, in many respects, problematic in spite of numerous investigations. Some results, obtained in coprecipitation studies on Ca^{45}, Fe^{59}, Zn^{65}, and Tl^{204} in distilled and tap water with or without carriers, are discussed. A table shows the most favorable precipitation conditions or results on additional radioisotopes, which were partially studied. (tr-auth)

2647 INVESTIGATION OF THE APPLICABILITY OF AN ALBANIAN CLAY FOR PURIFICATION OF RADIOACTIVE WASTE SOLUTIONS. G. Sachse (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Kernenergie, 5: 554-8 (July 1962). (In German)

In the purification of radioactive waste solutions clays offer special advantages as natural cheap ion-exchange materials. A gabbro mixture of Albanian origin was investigated as a clay exchanger. In addition to a survey on the mineralogical characterization of the material studied by element analysis, Debye-Scherrer diagrams, electron microscopic investigations, and differential thermal analysis were used to determine the exchange behavior for cesium, strontium, and cerium ions. The exchange capacity of the clays lies between 0.5 and 0.8 mval/g, depending on the type of exchanging cations. Investigations on the fixation of the exchanged ions on clay samples were described in conclusion. (tr-auth)

2648 ANACONDA SUCCESSFULLY DISPOSES URANIUM MILL WASTE WATER BY DEEP WELL INJECTION. R. D. Lynn and Z. E. Arlin (Anaconda Co., Grants, N. Mex.). Mining Engr., 49-52(July 1962).

Disposal of mildly acidic excess mill waste water containing a low level of radioactivity due to small amounts of natural U, Th^{230}, and Ra^{226} by deep well injection was investigated. A study of the regional geology and hydrology of Grants, New Mexico, indicated that a disposal well was feasible, and a test well to basement rock was planned. It was also determined that, after the process waste water was discharged to a tailing pond and subjected to partial loss by evaporation, there would still be about 400 gpm available for injection into the disposal well. The selected location was on the northeast flank of the Zuni Uplift, within the extreme southern limits of the San Juan Basin in northwest New Mexico. Construction of the well, surface installations, behavior of injected waste water, and monitor program are discussed. (P.C.H.)

2649 EXPERIMENTAL PRINCIPLES FOR THE CONSTRUCTION OF THE WASTE TREATMENT PLANT AT THE HOT LABORATORY OF THE EIR IN WÜRENLINGEN. H. R. von Gunten (Eidg. Institut für Reaktorforschung, Würenlingen Switzerland). Neue Tech., 4: 395-403(Aug. 1962). (In German)

Laboratory scale tests for the design of the treatment plant for low activity waste at the EIR are described. The conditions for the precipitation of calcium phosphate-ferric hydroxide flocs were investigated in detail, and decontamination factors are given. Methods for the filtration and drying of the precipitates were tested. Experiments with vermiculite ion-exchangers of different origin showed good results if the mineral is used in combination with the floc treatment. (auth)

2650 PRESENT AND FUTURE PROGRAMS IN THE TREATMENT AND ULTIMATE DISPOSAL OF HIGH LEVEL RADIOACTIVE WASTES IN THE UNITED STATES. W. G. Belter (Atomic Energy Commission, Washington, D. C.). IAEA Preprint No. SM-31/6. 33p. (TID-17173)

To be published in IAEA Proceedings of the Symposium on the Treatment and Storage of High-Level Radioactive Wastes, held in Vienna, October 8-13, 1962.

Conversion to solids methods, including the use of fluid beds, heated pots, radiant-heated spray columns, rotary kilns, and ceramic sponges, are under study. The addition of glass-forming materials to the waste for providing a more stable final product is also being investigated. Some of the advantages and disadvantages of each process are noted. The present status of these development projects is summarized and the proposed future program plans are stated. The investigation of specific geologic formations, such as salt structures, deep permeable basins, and impermeable crystalline rock, for the ultimate storage or disposal of calcined solids or certain types of liquid wastes is described. Plans for a proposed field experiment in salt with full-scale activity are discussed. The exploratory drilling program at the Savannah River Plant to determine the feasibility of storing aged, first-cycle wastes in the basement rock below SRP is described briefly and preliminary results are noted. Brief reference is made of the long-range engineering studies to evaluate the hazards and economics of various methods for handling, storage, and/or ultimate disposal of highly radioactive liquid and solid wastes. The role of this engineering evaluation program in relation to future program planning in waste management is discussed. (auth)

2651 DESIGN OF A HOT PILOT PLANT FACILITY FOR DEMONSTRATION OF THE POT CALCINATION PROCESS. J. A. Buckham (Phillips Petroleum Co., Idaho Falls, Idaho). IAEA Preprint No. SM-31/18. 32p. (TID-17176)

To be Published in IAEA Proceedings of the Symposium on the Treatment and Storage of High-Level Radioactive Wastes, held in Vienna, October 8-13, 1962.

A facility was designed for demonstration of the pot calcination process with wastes from processing aluminum alloy fuels, Darex or electrolytic processing of stainless-steel fuels, and Purex processes. This facility will also permit determination of precedures required for economical production of low-porosity, relatively nonleachable materials by addition of suitable reagents to the wastes fed to the calciner. The process consists of concentration by evaporation and thermal decomposition in situ in pots which also serve as the final disposal containers. This unit permits determination of pot loading and density, leachability, melting point, volatile material content, heat release, and thermal conductivity of the calcine. Also to be determined are transient calcine temperature distributions, fission product behavior during calcination, deentrainment obtained in the various parts of the system, decontamination achieved on all liquid and gaseous effluent streams, need for venting of stored pots, optimum means of remotely sealing the pots, and methods required for production of a minimum volume of noncondensable off-gas. This facility will employ nominal full-scale pots 8 and 12 in. in diameter and 8 ft long. A unique evaporator design was evolved to permit operation either with close-coupled continuous feed preparation or with bath feed preparation. Provisions were made to circumvent possible explosions due to organic material in feed solutions and other suspected hazards. (auth)

2652 PILOT PLANT STUDIES OF THE FLUIDIZED BED WASTE CALCINATION PROCESS. J. A. Buckham and J. A. McBride (Phillips Petroleum Co., Idaho Falls, Idaho). IAEA Preprint No. SM-31/17. 34p. (TID-17177)

To be Published in IAEA Proceedings of the Symposium on the Treatment and Storage of High-Level Radioactive Wastes, held in Vienna, October 8-13, 1962.

Studies were conducted in 6- and 12-in. dia. electrically heated fluidized beds and in a 24-in.-square NaK-heated bed and are being extended in the two larger units. Although exploratory studies demonstrated the feasibility of this process for stainless steel and zirconium fuel wastes, the overwhelming majority of the work was with aluminum fuel wastes. Feed rates from 5 to 150 l/hr per air-atomizing nozzle were used with no perceptible tendency toward caking; capacity of all units was limited by the rate of heat introduction through internal surfaces. Measured heat transfer coefficients range from 40 to 110 Btu/hr-°F-ft^2, depending upon bed particle size and fluidized bed density. Particle size was controlled by varying the atomizing air rate, the major factor governing particle attrition; quantitatively this effect is very dependent on the crystalline form of alumina produced. Various operating factors make significant differences in the rate of conversion of amorphous alumina calcine to the alpha, gamma, or iota form. Particle attrition increases with alpha alumina content; hence, average bed particle size decreases and particle elutriation rate increases with increasing alpha content. High alpha-content beds are more dense and contain less nitrate, both desirable features. Sodium is a necessary feed ingredient for alpha alumina formation; its effect can be overcome by addition of boric acid to the feed. Addition of one of these components to the feed is recommended to obtain the desired product form. Superficial fluidizing velocities from 0.5 to 2.5 fps were used; best results are obtained with velocities under 1.0 fps. Studies were made with and without condensing the off-gas stream and with near-total recycle of non-condensable off-gas for fluidization. The latter method of operation shows promise for minimizing atmospheric contamination. Performance data from preliminary operation of a 48-in.-dia. demonstrational waste calcining facility are reported. (auth)

2653 CONTINUOUS CALCINATION OF HIGH LEVEL RADIOACTIVE WASTES BY MEANS OF A ROTARY BALL KILN. W. H. Regan, L. P. Hatch, and R. F. Domish (Brookhaven National Lab., Upton, N. Y.). IAEA Preprint No. SM-31/7. 17p. (TID-17209)

To be Published in IAEA Proceedings of the Symposium on the Treatment and Storage of High-Level Radioactive Wastes, held in Vienna, October 8-13, 1962.

Decomposition of wastes, namely, aluminum nitrate, zirconium fluoride, and ferric nitrate, to their respective oxides introduces a number of serious operations problems. One promising type of calciner under development is the rotary ball kiln. Basically, the unit consists of a slowly rotating horizontal tube or kiln externally heated by means of electric resistance heaters. Feed is introduced into the kiln by means of a distribution nozzle, and falls on a hot, shallow bed of metal balls, which aid in heat transfer and prevent the formation of large agglomerates during calcination. The calcined solids overflow from the discharge end of the kiln into a powder receiver. The calciner is designed for continuous operation, to give good transfer of heat to the interior of the kiln, and to reduce problems of control of radioactive dust to a bare minimum. Since no noncondensable gases are added to the system, excellent dust control is accomplished by direct condensation of off-gases followed by passing the small non-condensable portion through a scrubber and absolute filter. An engineering scale calciner was constructed and used to carry out equipment and process development studies. The rotary kiln is 8-in. in dia., has a heated length of 7 ft, and is designed to calcine approximately 6 gal of waste per hr. Rotary gas seals are described. Results of the pilot plant operation with simulated nonradioactive aluminum nitrate waste feed are discussed. (auth)

2654 ULTIMATE STORAGE OF HIGH-LEVEL WASTE SOLIDS AND LIQUIDS IN SALT FORMATIONS. R. L. Bradshaw, W. J. Boegly, Jr., F. M. Empson, H. Kubota, F. L. Parker, J. J. Perona, and E. G. Struxness (Oak Ridge National Lab., Tenn.). IAEA Preprint No. SM-31/10. 33p. (TID-17175)

To be Published in IAEA Proceedings of the Symposium on the Treatment and Storage of High-Level Radioactive Wastes, held in Vienna, October 8-13, 1962.

Salt formations offer an attractive site for ultimate storage of high-level liquid and solid wastes. Salt formations are impermeable, have good structural strength, and good thermal conductivity. Elevating the temperature of 3000 gal of waste in a 7½-ft square cavity to 65°C did not upset the structural stability of a mine room, even though the floor-to-ceiling dimensions decreased by ½ in. at a distance of 5 ft from the cavity. Evaporation of solution with subsequent condensation on the walls produces some alteration of the cavity. Adsorption of the waste solution onto crushed salt appears to retard both cavity alteration and the production of radiolytic decomposition gases. Radiation doses to be expected in an actual disposal operation will not be great enough to affect the structural stability of

the rooms significantly. The major remaining uncertainty is the effect on structural stability of elevating the temperature of large areas of a mine. A theoretical and experimental investigation of this problem is currently under way. Temperature rise calculations were performed for the storage of wastes from a 6-ton/day fuel processing plant. For liquids the waste was assumed to be adsorbed onto granular salt in rooms with recessed floors. The net mine area required to limit the waste temperature rise to 70°C varied from 34 acres/yr for 120-day-old wastes to 5 acres/yr for 30-year-old wastes. If the wastes are stored in solid form above the mine floor, the acreage requirements are reduced by a factor of 2.3. For cylindrical vessels stored in holes in the mine floor, calculations showed that for wastes cooled longer than three years the space requirements are the same as for solids above the floor. (auth)

2655 ECONOMIC EVALUATION OF TANK STORAGE AND POT CALCINATION OF POWER REACTOR FUEL REPROCESSING WASTES. J. J. Perona, R. L. Bradshaw, J. T. Roberts, and J. O. Blomeke (Oak Ridge National Lab., Tenn.). IAEA Preprint No. SM-31/11. 39p. (TID-17207)

To be Published in IAEA Proceedings of the Symposium on the Treatment and Storage of High-Level Radioactive Wastes, held in Vienna, October 8-13, 1962.

Costs were estimated for interim storage of wastes in tanks and conversion to solids by pot calcination. A 6-ton/day capacity fuel processing plant was assumed, processing 1500 tons/year of uranium fuel of 10,000 Mwd/ton burnup and 270 tons/year of thorium fuel of 20,000 Mwd/ton burnup, which would process all the fuel from a 15,000-Mw_e nuclear economy. Costs for storage of acidic and neutralized Purex and Thorex wastes were estimated for storage in stainless steel tanks for acidic wastes and mild steel for neutralized wastes. With interim storage time defined as filling time plus full time, tank costs were minimum when the full time was roughly 40 to 75% of the interim storage time. For 0.5-30-yr storage, costs ranged from 2.0×10^{-3} mill/kwh_e for acid wastes and from 1.5×10^{-3} to 4.7×10^{-3} mill/kwh_e for alkaline wastes. Costs were estimated for converting acidic and reacidified Purex and Thorex wastes to solids by pot calcination and for producing glass from acidic Thorex wastes. The vessels studied were made of 6-, 12-, and 24-in.-dia. stainless steel pipe, 10 ft high, with estimated costs of $500, $855, and $2515. Aging had negligible effect on costs for processing in a vessel of a given size, because capital costs were only about 10% of vessel and operating costs, but permitted larger vessels to be used; costs for processing in 6-in.-dia. vessels were two to three times those in 24-in.-dia. vessels. The lowest cost was 0.87×10^{-2} mill/kwh_e for processing acidic Purex and Thorex wastes in 24-in.-dia. vessels, and the highest was 5.0×10^{-2} mill/kwh_e for processing reacidified Purex and Thorex wastes in 6-in.-dia. vessels. (auth)

CORPORATE AUTHOR INDEX

This index contains entries for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

Each entry under a corporate author is a shortened version of the title of the publication, followed by the *NSA* volume and abstract number. Report numbers are given in parentheses.

The phrase "Progress report" is abbreviated as "Prog. rpt." This change permits a more rapid and complete alphabetical arrangement of the titles without changing the location of the progress report titles in relation to the other titles.

A

AEROJET-GENERAL NUCLEONICS, SAN RAMON, CALIF.
PECAN II—code for nuclear or conventional power plants, 17: 1579 (AGN-TM-391-II)

AEROSPACE CORP., EL SEGUNDO, CALIF.
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Because of problems involving the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

æ	becomes	ae
ö		oe
ø		oe
ü		ue (except in transliterated Chinese names)

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As an aid to the users of this index, references to report numbers, where appropriate, are included after the abstract number of the citation.

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REPORT NUMBER INDEX

All reports, translations, and patents abstracted in this issue are included in this index. Each item is listed by report number; this is followed by the abstract number and a brief notation regarding public availability. The index entries show, when known, which reports are on file in the depository libraries, which reports have been published in open-literature journals (journal citation given), and which reports can be purchased (source and price). Whenever a report is identified by more than one number, cross references from secondary to primary report numbers are cited.

The report number codes apply to AEC reports unless designated otherwise. Non-AEC reports are identified by parenthetical notes after the report codes; e.g., (non-AEC), (British), (Canadian), (French). The note (Misc.) identifies those codes used for both USAEC and non-AEC reports. The report numbers for the non-AEC reports in these series are marked with an asterisk (*). Patents are listed under the heading "PATENTS"; the country of origin is included in parentheses.

A comprehensive listing of both AEC and non-AEC report codes is contained in TID-85(2nd Rev.), *Report Number Series Used by the Technical Information Service in Cataloging Reports*. March 1960, $2.75 (OTS), and supplement, August 1960, $0.50 (OTS).

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Public Availability of Non-AEC Reports

U. S. Reports. Many reports of U. S. Government agencies other than the AEC can be obtained by the public in the same manner as AEC reports. The availability of these reports is given when known. If availability is not shown, inquiries should be directed to the Office of Technical Services. Inquiries concerning "NP" reports should be by title and author rather than by NP number.

Non-U. S. Reports. Many reports of atomic energy establishments of other countries are placed in the depository libraries in the United States, where they are available for public use. Other reports appear in the journal literature. Some British reports are sold by the British Information Service, 45 Rockefeller Plaza, New York 20, N. Y. Some Canadian reports are sold by Atomic Energy of Canada Ltd., Chalk River, Ontario, Canada. This index identifies any type of public availability known to the USAEC.

Abbreviations Used in Availability Column

AECL	For sale by Atomic Energy of Canada Ltd., Chalk River, Ontario, Canada.
BIS	For sale by the British Information Service, 45 Rockefeller Plaza, New York 20, N. Y.
Dep.	AEC reports: Full-size copy is on deposit in the depository libraries both in and outside the United States. These reports are also for sale by Microcard Editions, Inc., Accounting and Shipping Department, West Salem, Wisconsin. Non-AEC reports: Full-size copy on deposit in the depository libraries in the United States only.
Dep.(mc)	Same as for Dep., except copy is in Microcard form.
DSIR	For sale by the Department of Scientific and Industrial Research, Lending Library Unit, 20 Chester Terrace, London, N. W. 1, England.
DTI Extension	Available from the U. S. Atomic Energy Commission, Division of Technical Information Extension, P. O. Box 62, Oak Ridge, Tennessee.
GPO	For sale by the Superintendent of Documents, Government Printing Office, Washington 25, D. C.
HMSO	Her Majesty's Stationery Office, London.
IAEA	Available from the International Atomic Energy Agency.
JCL	For sale by the Special Libraries Association Translation Center, John Crerar Library, 86 E. Randolph Street, Chicago 1, Illinois.
NRC	For sale by the National Research Council of Canada, Ottawa, Ontario, Canada.
OTS	For sale by the Office of Technical Services, Department of Commerce, Washington 25, D. C.
USGS	Available free-of-charge from the U. S. Geological Survey, Washington 25, D. C.

(The symbols "ph," "mf," and "fs" are used to designate that copy is available only in photostat, microfilm, or facsimile (Xerox) form.)

Report No.	Abstract No.	Availability
NUMERICAL	**(Misc.)**	
60GL188(Del.)	17-1708	See TID-16570(Del.)
62AS-12*	17-1897	See NP-12144
A-AC–	**(Misc.)**	
82/G/L.703*	17-1631	Dep.(mc)
AAEC-E–	**(Australian)**	
94	17-1358	Dep.(mc)
96	17-1999	Dep.(mc)
97	17-1869	Dep.(mc)
ACNP–		
62002	17-2573	Dep.(mc); $11.00(fs), $4.64(mf) OTS
AD–	**(Misc.)**	
58695*	17-1956	See WADC-TR-54-276
271836*	17-2064	See FTD-TT-62-65
273078*	17-1742	See AFOSR-1729
273481*	17-1916	See ARF-2215-6
273594*	17-1927	See DCAS-TR-61-28
273746*	17-1887	$2.60(OTS)
273825*	17-1165	OTS
273861*	17-1744	See DASA-1275
274206*	17-1915	$1.60(OTS)
274652*	17-2140	See AFCRL-62-270
274686*	17-2415	See RIA-62-654
274694*	17-2361	See DCAS-TDR-62-20
274740*	17-2049	OTS
276268*	17-1888	See ASC-TR-7-786(I)
287076*	17-1234	See AF-SAM-62-51
287649*	17-2011	See USNRDL-TR-577
287202*	17-1751	See USNRDL-TR-580
287903*	17-1566	See USNRDL-TR-588
286672*	17-1917	See ARL-62-427(Pt.II)
287847*	17-2141	See AFCRL-62-651
288017*	17-2144	See AFCRL-62-675
285569*	17-1918	See ASD-TDR-62-432
288019*	17-1889	See ASD-TDR-62-506
AEC-tr–		
5423	17-1243	Dep.(mc); $1.60(fs), $0.80(mf) JCL or OTS
5455	17-1659	Dep.(mc); $1.10(fs), $0.80(mf) JCL
5459	17-1958	Dep.(mc); $3.60(fs), $1.19(mf) JCL or OTS
5465	17-2171	Dep.(mc); $3.60(fs), $1.28(mf) JCL
5477	17-1362	Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS
5493	17-2247	Dep.(mc); $3.60(fs), $1.40(mf) JCL or OTS
5496	17-1819	Dep.(mc); $1.10(fs)($0.80(mf) JCL
5497	17-1820	Dep.(mc); $1.10(fs), $0.80(mf) JCL
5515	17-1363	Dep.(mc); $5.60(fs), $1.85(mf) JCL
5517	17-1610	Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS
5518	17-1611	Dep.(mc); $1.60(fs), $0.80(mf) JCL or OTS
5519	17-1612	Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS
5533	17-1821	Dep.(mc); $2.60(fs), $0.83(mf) JCL
AECL–	**(Canadian)**	
1589	17-2002	See CRRM-1097
1601	17-2468	See CRRP-985-E
1608	17-2469	See DL-52
AERE-AM–	**(British)**	
85	17-1374	Dep.; $0.35(BIS); 2s. 6d.(HMSO)
90	17-1375	Dep.; $0.25(BIS); 1s. 9d.(HMSO)
AERE-I–	**(British)**	
R-2641	17-1740	Dep.(mc)
AERE-M–	**(British)**	
595	17-1741	Dep.(mc)
966	17-1768	Nucl. Instr. Methods 16: 321-5(1962)
AERE-R–	**(British)**	
3802	17-1849	p.420-32 of "Powder Metallurgy in the Nuclear Age. Plansee Proceedings 1961."
4014	17-2100	Phil. Mag. (8), 7: 1425-8(1962)
4044	17-2099	Phil. Mag. (8), 7: 1385-1405(1962)
AF-SAM–	**(Non-AEC)**	
62-51	17-1234	$1.60(fs) OTS
AFCRL–	**(Non-AEC)**	
62-270	17-2140	OTS
62-651	17-2141	$1.60(fs) OTS
62-675	17-2144	
AFOSR–	**(Misc.)**	
1729*	17-1742	OTS
AGN-TM–		
391-II	17-1579	Dep.; $0.50(OTS)
AHSB(S)–	**(British)**	
R-31	17-2457	Dep.; $0.35(BIS); 2s. 6d.(HMSO)
ANL–		
6314	17-1815	Dep.; $0.50(OTS)
6569	17-1359	Dep.; $2.75(OTS)
6614	17-2612	Dep.; $1.25(OTS)
6624	17-1166	Dep.; $3.00(OTS)
ANL-FGF–		
248	17-1905	J. Am. Ceram. Soc. 45: 505-6(1962)
262	17-1984	See TID-13235
333	17-1988	Trans. Met. Soc. AIME 224: 1082-3(1962)
381	17-1870	Dep.(mc); $1.10(fs), $0.80(mf) OTS
385	17-1871	Dep.(mc); $3.60(fs), $1.16(mf) OTS
ANLAD–		
69	17-2340	See TID-17059
AP-NOTE–	**(Misc.)**	
129*	17-2477	See NP-12187
ARF–	**(Misc.)**	
1209-6	17-2050	Dep.(mc); $1.60(fs), $0.80(mf) OTS
22516-6*	17-1916	OTS
ARL–	**(Non-AEC)**	
62-427(Pt.II)	17-1917	$6.60(fs) OTS
ASC-TR–	**(Non-AEC)**	
7-786(I)	17-1888	$3.60(OTS)
ASD-TDR–	**(Non-AEC)**	
62-432	17-1918	$2.25(fs) OTS
62-506	17-1889	$2.25(fs) OTS
ASRL-TR–	**(Non-AEC)**	
94-4	17-1919	
AWRE-NR–	**(British)**	
A-2/62	17-1524	Dep.(mc)
BLG–	**(Belgian)**	
126	17-1683	Dep.(mc)
128	17-1317	Radiation Research 16: 728-35(1962)
BM-RI–	**(Misc.)**	
6078*	17-1920	Free(Bureau of Mines)
6091*	17-1376	Free(Bureau of Mines)
6097*	17-1377	Free(Bureau of Mines)

Report No.	Abstract No.	Availability
BMI-B&W–	**(Misc.)**	
653*	17-1872	
654*	17-2000	
BMI-X–		
10015	17-2458	Dep.(mc); $1.10(fs), $0.80(mf) OTS
10016	17-1816	Dep.(mc); $1.10(fs), $0.80(mf) OTS
10019	17-1921	Dep.(mc); $1.60(fs), $0.80(mf) OTS
10021	17-1513	Dep.(mc); $1.60(fs), $0.80(mf) OTS
BNL–		
731	17-2459	Dep.; $2.25(OTS)
6305	17-2205	Dep.(mc); $1.10(fs), $0.80(mf) OTS
6308	17-2574	Dep.(mc); $1.10(fs), $0.80(mf) OTS
6309	17-2466	Dep.(mc); $1.10(fs), $0.80(mf) OTS
6310	17-2467	Dep.(mc); $1.10(fs), $0.80(mf) OTS
6322	17-1922	Dep.(mc); $1.60(fs), $0.80(mf) OTS
6338	17-1923	Dep.(mc); $2.60(fs), $0.92(mf) OTS
6375	17-2001	Dep.(mc); $1.60(fs), $0.80(mf) OTS
6513	17-2009	See TID-17180
BRB–		
54	17-1890	Dep.(mc); $2.60(fs), $1.07(mf) OTS
58	17-1891	Dep.(mc); $5.60(fs), $1.91(mf) OTS
61	17-1892	Dep.(mc); $3.60(fs), $1.19(mf) OTS
CEA–	**(French)**	
2104	17-1924	Dep.(mc)
2116	17-1925	Dep.(mc)
2161	17-1555	Dep.(mc)
2178	17-1580	Dep.(mc)
2182	17-1743	Dep.(mc)
CEA-Bib–	**(French)**	
23	17-1378	Dep.(mc)
CEA-tr–	**(French)**	
A-1057	17-2482	Dep.(mc); $2.60(fs), $0.92(mf) JCL
R-1611	17-1200	Dep.(mc); $1.60(fs), $0.80(mf) JCL or OTS
X-457	17-1392	Dep.(mc); $1.60(fs), $0.80(mf) JCL
CEND–	**(Misc.)**	
2010/RS/58	17-1625	Dep.(mc); $1.60(fs), $0.80(mf) OTS
CERN-EAG–	**(European Organization for Nuclear Research)**	
3	17-2336	Dep.(mc)
CNI–	**(Italian)**	
105	17-1450	Minerva Nucl. 5: 97-101(1961)
CRRM–	**(Canadian)**	
1097	17-2002	Dep.; $1.00(AECL)
CRRP–	**(Canadian)**	
985-E	17-2468	Dep.; $1.50(AECL)
CU(PNPL)–		
219	17-2051	Dep.(mc); $5.60(fs), $1.79(mf) OTS
D–	**(Misc.)**	
1-82-0194*	17-1926	
1-82-0198*	17-2360	
DANATOM–	**(Danish)**	
04-62	17-2575	Dep.(mc)
DASA–	**(Misc.)**	
1275*	17-1744	$10.50(fs) OTS
DC–	**(Misc.)**	
60-1-4	17-1807	Dep.(mc); $6.60(fs), $2.21(mf) OTS

Report No.	Abstract No.	Availability
DCAS-TDR–	**(Non-AEC)**	
62-20	17-2361	$2.60(fs) OTS
DCAS-TR–	**(Non-AEC)**	
61-28	17-1927	OTS
DESY-A–	**(German)**	
2.92	17-1698	Dep.(mc)
2.93	17-1699	Dep.(mc)
DL–	**(Non-AEC)**	
52	17-2469	Dep.; $0.50(AECL)
DM–	**(Non-AEC)**	
62-217	17-1897	See NP-12144
DMIC-Memo–	**(Non-AEC)**	
160	17-1928	
DP–		
734	17-1379	Dep.; $0.50(OTS)
750	17-1416	Dep.; $0.50(OTS)
766	17-1380	Dep.; $0.50(OTS)
780	17-1745	Dep.; $0.50(OTS)
DPSPU–		
62-30-21B	17-2639	Dep.(mc); $3.60(fs), $1.31(mf) OTS
DUBNA REPORTS	**(Russian)**	
See JINR (Russian)		
EIR–	**(Swiss)**	
28	17-2470	Dep.(mc)
EP–	**(Misc.)**	
4422-269-62U	17-1583	See UVA-269-62U
ER–	**(Misc.)**	
5084*	17-2363	See NP-12191
EUR–	**(Belgian)**	
12.e	17-2220	Dep.(mc)
EURAEC–		
279	17-1959	Dep.(mc); $9.60(fs), $3.74(mf) OTS
331	17-1900	Dep.(mc); $8.10(fs), $2.63(mf) OTS
343	17-1960	Dep.(mc); $2.60(fs), $0.95(mf) OTS
344	17-1961	Dep.(mc); $2.60(fs), $0.83(mf) OTS
364	17-1393	Dep.(mc); $3.60(fs), $1.28(mf) OTS
375	17-1901	Dep.(mc); $4.60(fs), $1.55(mf) OTS
385	17-1962	Dep.(mc); $1.10(fs), $0.80(mf) OTS
397	17-1902	Dep.(mc); $6.60(fs), $2.21(mf) OTS
452	17-2458	See BMI-X-10015
456	17-2472	See GNEC-251
466	17-1921	See BMI-X-10019
467	17-1816	See BMI-X-10016
FTD-TT–	**(Non-AEC)**	
62-65	17-2064	OTS
62-890	17-2366	OTS
62-1045	17-2208	OTS
62-1256	17-1963	OTS
FZK–	**(Non-AEC)**	
9-161	17-2620	See NARF-61-19R
GA–	**(Misc.)**	
3588	17-1929	Dep.(mc); $8.10(fs), $2.72(mf) OTS
GAMD–	**(Misc.)**	
2676	17-2471	Dep.(mc); $2.60(fs), $0.95(mf) OTS

Report No.	Abstract No.	Availability
3254	17-2576	Dep.(mc); $1.60(fs), $0.80(mf) OTS
GAT-T–		
970	17-1417	Dep.(mc); $1.10(fs), $0.80(mf) OTS
GCA–	**(Non-AEC)**	
(10-S)-61-68(Del.)	17-2142	
GNEC–		
214	17-2577	Dep.(mc); $9.10(fs), $3.29(mf) OTS
251	17-2472	Dep.(mc); $8.10(fs), $2.63(mf) OTS
HAVENS–		
141	17-1890	See BRB-54
HW–		
64590(Rev.3)	17-2003	Dep.(mc); $1.60(fs), $0.80(mf) OTS
66804(Rev.)	17-2473	Dep.(mc); $1.60(fs), $0.80(mf) OTS
68420(Rev.)	17-2578	Dep.; $2.75(OTS)
69200(Pt.I)	17-1893	Dep.; $1.75(OTS)
70050	17-1173	Dep.; $3.50(OTS)
71051	17-1700	Dep.; $0.50(OTS)
71137	17-2613	Dep.(mc); $2.60(fs), $0.98(mf) OTS
73382	17-1873	Dep.(mc); $2.60(fs), $0.83(mf) OTS
73859(Rev.)	17-1930	Dep.; $0.50(OTS)
74339	17-1931	Dep.; $2.00(OTS)
74371	17-2640	Dep.(mc); $1.60(fs), $0.80(mf) OTS
74422	17-2614	Dep.(mc); $1.10(fs), $0.80(mf) OTS
74802	17-1932	Dep.; $0.75(OTS)
75148	17-1933	Dep.(mc); $1.10(fs), $0.80(mf) OTS
HW-SA–		
2017	17-2615	Dep.(mc); $1.60(fs), $0.80(mf) OTS
2278	17-1183	Arch. Environ. Health 5: 167-72(1962)
2669	17-1225	Proc. Soc. Exptl. Biol. Med. 111: 429-31 (1962)
2680	17-1894	Dep.(mc); $2.60(fs), $0.89(mf) OTS
2711	17-2474	Dep.(mc); $5.60(fs), $1.79(mf) OTS
2748	17-2641	Dep.(mc); $1.60(fs), $0.80(mf) OTS
2750	17-2156	Dep.(mc); $3.60(fs), $1.40(mf) OTS
2755	17-1934	Dep.(mc); $1.60(fs), $0.80(mf) OTS
2757	17-1895	Dep.(mc); $2.60(fs), $0.83(mf) OTS
2778	17-1935	Dep.(mc); $1.60(fs), $0.80(mf) OTS
2782	17-1936	Dep.(mc); $1.60(fs), $0.80(mf) OTS
2783	17-1896	Dep.(mc); $1.60(fs), $0.80(mf) OTS
2787	17-1606	Dep.(mc); $2.60(fs), $1.04(mf) OTS
2803	17-1937	Dep.(mc); $3.60(fs), $1.37(mf) OTS
IA–	**(Non-AEC)**	
751	17-1632	Dep.(mc)
767	17-1179	Dep.(mc)
IDO–		
14581	17-1938	Dep.; $0.50(OTS)
14591	17-1381	Dep.; $0.50(OTS)
14593	17-1564	Dep.; $1.00(OTS)
16086	17-2617	Dep.; $1.00(OTS)
16756	17-2579	Dep.; $1.25(OTS)
16793	17-2580	Dep.; $1.50(OTS)
IEA–	**(Non-AEC)**	
52	17-2221	Dep.(mc)
53	17-1382	Dep.(mc)
IS–		
245	17-2089	J. Chem. Phys. 37: 1496-1508(1962)
506	17-2160	Dep.; $2.50(OTS)
JINR–	**(Russian)**	
E-1032	17-2145	Dep.(mc)
E-1061	17-2420	Phys. Letters, 2: 305(1962)
P-1010	17-2222	Dep.(mc)
P-1013	17-2337	Dep.(mc)
P-1014	17-2161	Dep.(mc)
P-1017	17-2052	Dep.(mc)
P-1018	17-2162	Dep.(mc)
P-1028	17-2053	Dep.(mc)
P-1043	17-2163	Dep.(mc)
P-1047	17-2164	Dep.(mc)
P-1056	17-2165	Dep.(mc)
P-1060	17-2166	Dep.(mc)
JPRS–	**(Non-AEC)**	
15517	17-2065	OTS
15907	17-1822	OTS
15920	17-1660	$4.60 OTS or SLA
15923	17-2367	OTS
15978	17-1823	OTS
JUL–	**(German)**	
50-RE	17-2618	Dep.(mc)
53-PP	17-1701	Dep.(mc)
61-PP	17-2362	Dep.(mc)
K–		
1543	17-1607	Dep.(mc); $1.60(fs), $0.80(mf) OTS
KAPL–		
2214	17-2223	Dep.; $1.50(OTS)
KAPL-M–		
EPS-2	17-1808	Dep.(mc); $1.60(fs), $0.80(mf) OTS
FHG-1	17-1383	Dep.(mc); $1.10(fs), $0.80(mf) OTS
FTG-1	17-1746	Dep.(mc); $4.60(fs), $1.70(mf) OTS
KFK–	**(German)**	
102	17-1800	Z. Naturforsch. 17a: 432-8(1962)
104	17-2504	Nukleonik 4: 84-91(1962)
KFK-tr–	**(German)**	
111	17-1752	Dep.(mc); $3.60(fs), $1.31(mf) JCL
114	17-2248	Dep.(mc); $1.60(fs), $0.80(mf) JCL
115	17-1687	Dep.(mc); $1.60(fs), $0.80(mf) JCL
KR–	**(Norwegian)**	
25	17-2581	Dep.(mc)
27	17-2475	Dep.(mc)
28	17-2054	Dep.(mc)
KT–		
530	17-2642	Dep.(mc); $1.60(fs), $0.80(mf) OTS
LA–		
1589	17-2206	Dep.(mc); $1.60(fs), $0.80(mf) OTS
LADC–		
1644	17-2206	See LA-1589
3783	17-1440	J. Electrochem. Soc. 109: 895-902(1962)
4883	17-1419	See TID-13975
5347	17-1438	J. Chem. Phys. 37: 1473-6(1962)
5354	17-1626	Dep.(mc); $2.60(fs), $1.01(mf) OTS
5408	17-2619	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5445	17-1939	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5447	17-1748	Dep.(mc); $2.60(fs), $1.04(mf) OTS
5449(Rev.)	17-2055	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5459	17-2056	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5471	17-1817	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5489	17-1167	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5501	17-1657	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5524	17-1702	Dep.(mc); $3.60(fs), $1.16(mf) OTS
5539	17-1809	Dep.(mc); $2.60(fs), $1.07(mf) OTS

Report No.	Abstract No.	Availability
LAMS–		
2698(Rev.)	17-2157	Dep.; $2.00(OTS)
2782	17-2582	Dep.; $0.50(OTS)
LS–	**(Israeli)**	
101	17-1791	Dep.(mc)
MATT–		
102	17-2450	J. Math. Phys. 3: 1028-39(1962)
MF–	**(Misc.)**	
32	17-2364	See NYO-10424
MLM–		
1088(Suppl.)	17-1792	Dep.(mc)
MND-C–		
2500-1	17-1810	Dep.(mc); $13.50(fs), $6.17(mf) OTS
2502	17-2158	Dep.; $2.50(OTS)
MND-P–		
2483-7	17-2627	Dep.; $0.50(OTS)
2640	17-1684	Dep.(mc); $5.60(fs), $2.00(mf) OTS
2707	17-1685	Dep.(mc); $10.10(fs), $4.01(mf) OTS
MSAR–	**(Misc.)**	
62-109	17-1874	Dep.(mc); $2.60(fs), $0.92(mf) OTS
MURA–	**(Misc.)**	
644	17-2338	Dep.; $0.50(OTS)
645	17-1811	Dep.; $0.50(OTS)
NAA-SR–		
5993	17-2476	Dep.(mc); $8.60(fs), $3.08(mf) OTS
6727	17-1812	Dep.(mc); $3.60(fs), $1.40(mf) OTS
7394	17-1703	Dep.; $0.75(OTS)
NARF–	**(Non-AEC)**	
61-19R	17-2620	
NDL-TR–	**(Non-AEC)**	
33	17-1658	
NIRL-R–	**(British)**	
16	17-2224	Dep.(mc)
NLCO–		
856	17-1704	Dep.; $0.75(OTS)
860	17-1556	Dep.; $1.75(OTS)
NP–	**(AEC File No. for Non-AEC Reports)**	
12087	17-2583	
12144	17-1897	
12155	17-1235	Dep.(mc)
12163	17-1360	
12165	17-1686	Dep.(mc)
12180	17-2004	
12181	17-1581	
12182	17-1747	Dep.(mc)
12185	17-1418	
12187	17-2477	Dep.(mc); $3.60(fs), $1.16(mf) OTS
12190	17-2057	
12191	17-2363	
12193	17-2005	Dep.(mc)
12195	17-2167	
12197	17-1940	
12207	17-2058	Dep.(mc)
12214	17-1941	
NYO–		
2670	17-2146	Dep.(mc); $8.60(fs), $2.99(mf) OTS
10424	17-2364	Dep.(mc); $3.60(fs), $1.19(mf) OTS
ORNL–		
3328	17-1230	Dep.; $11.50(fs), $4.76(mf) OTS
3346	17-1525	Dep.; $1.75(OTS)
3348	17-1705	Dep.; $2.50(OTS)
ORNL-TM–		
43	17-1452	Nucl. Sci. Eng. 14: 159-68(1962)
116	17-1453	Nucl. Sci. Eng. 14: 169-73(1962)
155	17-1454	Nucl. Sci. Eng. 14: 174-8(1962)
305	17-2059	Dep.(mc); $7.60(fs), $2.51(mf) OTS
ORO–		
579	17-1898	Dep.(mc); $4.60(fs), $1.64(mf) OTS
586(Vol.I)	17-2584	Dep.; $5.75(OTS)
PATENTS	**(Belgian)**	
600,262	17-1819	
600,263	17-1820	
PATENTS	**(British)**	**3s. 6d. each, U. K. Patent Office**
907,187	17-1560	
907,246	17-2539	
907,270	17-2540	
907,272	17-1782	
907,278	17-2541	
907,344	17-2542	
907,360	17-1910	
907,391	17-2543	
907,392	17-2544	
907,393	17-2545	
907,394	17-2546	
907,458	17-2547	
907,511	17-1731	
907,535	17-2548	
907,625	17-2549	
907,657	17-1801	
907,708	17-2602	
907,720	17-1561	
907,731	17-1997	
907,735	17-2550	
907,775	17-1371	
907,816	17-2603	
907,830	17-1574	
908,020	17-2411	
908,059	17-2551	
908,069	17-2552	
908,130	17-2553	
908,134	17-1588	
908,170	17-1623	
908,180	17-2554	
908,181	17-1867	
908,192	17-1553	
908,199	17-1372	
908,231	17-1589	
908,278	17-2555	
908,305	17-2556	
908,385	17-1630	
908,404	17-2604	
908,445	17-2626	
908,456	17-2557	
908,463	17-1590	
908,469	17-2605	
908,480	17-1591	
908,485	17-1783	
908,490	17-1732	
908,532	17-1592	
908,534	17-2558	
908,669	17-1593	
908,706	17-1594	

Report No.	Abstract No.	Availability
908,843	17-1733	
908,857	17-1911	
908,877	17-1595	
908,925	17-2606	
908,941	17-1912	
908,950	17-1784	
908,991	17-2607	
909,013	17-1624	
909,032	17-1696	
909,049	17-1913	
909,061	17-2046	
909,072	17-1914	
PATENTS	**(Canadian)**	
638,645	17-2559	
638,951	17-1802	
639,404	17-1575	
640,052	17-1596	
640,203	17-2560	
640,420	17-1576	
640,917	17-2561	
641,016	17-1803	
641,333	17-1804	
641,612	17-2562	
641,689	17-1734	
641,925	17-1785	
642,140	17-1868	
642,347	17-1735	
642,736	17-1886	
642,908	17-1597	
643,082	17-1736	
643,291	17-1682	
643,382	17-1562	
643,448	17-1415	
644,120	17-1598	
644,691	17-2412	
644,705	17-1805	
644,977	17-2418	
645,088	17-1563	
645,261	17-1599	
645,594	17-1600	
645,742	17-2563	
646,474	17-1510	
646,716	17-2564	
646,735	17-2565	
646,772	17-2566	
647,076	17-1737	
647,170	17-2567	
647,277	17-2568	
647,410	17-2608	
647,606	17-2359	
647,790	17-2419	
647,974	17-2569	
648,205	17-2413	
648,420	17-1786	
648,551	17-2570	
648,849	17-2616	
648,907	17-1787	
648,942	17-1577	
PATENTS	**(German)**	
20,009	17-2485	
20,446	17-2590	
20,720	17-2486	
20,899	17-2487	
20,977	17-2625	
21,004	17-2488	
21,079	17-2591	
21,090	17-2390	
21,099	17-2391	
21,219	17-2489	
21,268	17-2490	
21,291	17-2491	
21,374	17-2492	
21,515	17-2493	
21,532	17-2494	
21,667	17-2592	
21,948	17-1824	
PATENTS	**(U. S.)**	**$0.25 each, U. S. Patent Office**
3,056,647	17-1373	
3,056,672	17-1998	
3,056,736	17-2571	
3,056,737	17-1601	
3,056,848	17-1602	
3,056,885	17-1788	
3,056,886	17-1789	
3,056,912	17-1603	
3,057,677	17-1511	
3,057,684	17-1512	
3,057,735	17-1697	
3,057,791	17-2047	
3,057,793	17-2609	
3,057,818	17-2048	
3,057,996	17-1738	
3,057,998	17-1790	
3,058,000	17-1739	
3,058,022	17-1604	
3,058,023	17-1605	
3,058,801	17-1578	
3,058,811	17-1806	
3,058,897	17-2610	
3,058,898	17-2611	
3,058,899	17-1554	
3,058,900	17-2572	
3,059,149	17-2414	
PB–		
129969	17-1956	See WADC-TR-54-276
PG-Report–	**(British)**	
261	17-1384	Dep.
351	17-1385	Dep.; $0.42(BIS); 3s.(HMSO)
366	17-1386	Dep.
367	17-1387	Dep.
372	17-1388	Dep.; $0.21(BIS); 1s. 6d.(HMSO)
373	17-1389	Dep.
380	17-1390	Dep.; $0.21(BIS); 1s. 6d(HMSO)
PLASTEC–	**(Non-AEC)**	
12	17-2006	OTS
PWAC–	**(Misc.)**	
375*	17-1942	
RFP–		
267	17-1565	Dep.(mc); $1.60(fs), $0.80(mf) OTS
RIA–	**(Non-AEC)**	
62-654	17-2415	
RRL–	**(Misc.)**	
81	17-1535	J. Am. Chem. Soc. 84: 4000-4(1962)
90	17-1526	Dep.(mc); $1.60(fs), $0.80(mf) OTS
RT-BIO–	**(Italian)**	
(62)38	17-1272	Bull. Assoc. Anat. 47: 57-61(1961)
RT-EL–	**(Italian)**	
(62)7	17-1747	See NP-12182
RT-ING–	**(Italian)**	

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(62)4	17-2005	See NP-12193
SC–	**(Misc.)**	
4675(RR)	17-1168	Dep.; $4.00(OTS)
4733(M)	17-1706	Dep.; $0.50(OTS)
4735(RR)	17-1169	Dep.; $0.75(OTS)
4737(M)	17-2621	Dep.; $0.75(OTS)
SCDC–		
2843	17-2628	See TID-17210
2889	17-1948	See TID-17182
2895	17-1951	See TID-17276
SCL-T–		
438	17-1423	Dep,(mc); $1.10(fs), $0.80(mf) JCL or OTS
441	17-2068	Dep.(mc); $1.60(fs), $0.80(mf) JCL
SR–	**(Misc.)**	
72*	17-1581	See NP-12181
STI-PUB–	**(International Atomic Energy Agency)**	
15/25	17-1909	$1.00(IAEA)
15/26	17-2515	$1.00(IAEA)
TDR–	**(Non-AEC)**	
930(2220-50) TR-1	17-1927	See DCAS-TR-61-28
930(2220-50) TR-2	17-2361	See DCAS-TDR-62-20
TEI–		
788	17-1633	Dep.; $1.50(OTS)
794	17-1638	Geophysics 27: 599-610(1962)
807	17-1653	U. S. Geol. Survey. Profess. Paper, No. 450-C, C108-11(1962)
TID–		
6738	17-1213	Clin. Sci. 20: 333-43(1961)
13235	17-1984	Trans. Am. Soc. Metals 55: 251-4(1962)
13593	17-1299	J. Gen. Physiol. 45: 703-24(1962)
13594	17-1300	J. Gen. Physiol. 45: 725-41(1962)
13887	17-1943	Dep.(mc); $4.60(fs), $1.43(mf) OTS
13975	17-1419	Dep.(mc); $2.60(fs), $0.83(mf) OTS
14021	17-1707	Dep.(mc); $1.60(fs), $0.80(mf) OTS
14168	17-2060	Dep.(mc); $4.60(fs), $1.52(mf) OTS
14496	17-1884	Nucl. Sci. Eng. 14: 123-34(1962)
14603	17-2431	J. Math. Phys. 3: 831-42(1962)
14623	17-1985	Trans. Met. Soc. AIME 224: 935-9(1962)
14906	17-1420	Dep.(mc); $1.10(fs), $0.80(mf) OTS
15038	17-1426	Acta Cryst. 15: 1042-3(1962)
15096	17-1349	Radiation Res. 17: 792-800(1962)
15294	17-2044	p.133-48 of "Advances in Glass Technology." New York, Plenum Press, Inc., 1962
15344	17-2497	Nucl. Sci. Eng. 14: 204-6(1962)
15402	17-1231	New Engl. Med. 266: 1123-5(1962)
15758	17-2093	J. Chem. Phys. 37: 1578-9(1962)
16201	17-1208	Am. J. Physiol. 203: 907-13(1962)
16212	17-1517	J. Chem. Phys. 37: 1476-8(1962)
16455	17-1944	Dep.(mc); $9.10(fs), $3.26(mf) OTS
16570(Del.)	17-1708	Dep.(mc); $3.60(fs), $1.31(mf) OTS
16592	17-2061	Dep.(mc); $1.60(fs), $0.80(mf) OTS
16594	17-1534	J. Am. Chem. Soc. 84: 3994-9(1962)
16643	17-1538	J. Am. Chem. Soc. 84: 4053-9(1962)
16646	17-1309	Phys. Med. Biol. 7: 201-12(1962)
16860	17-1749	Dep.(mc); $1.60(fs), $0.80(mf) OTS
16867	17-2339	Dep.(mc); $2.60(fs), $0.83(mf) OTS
16879	17-1945	Dep.(mc); $5.60(fs), $1.79(mf) OTS
16888	17-1875	Dep.(mc); $3.60(fs), $1.22(mf) OTS
16949	17-2242	Dep.(mc); $15.00(fs), $7.01(mf) OTS
16973	17-1709	Dep.(mc); $5.60(fs), $2.00(mf) OTS
16980	17-1946	Dep.(mc); $6.60(fs), $2.21(mf) OTS
16995	17-2478	Dep.(mc); $1.10(fs), $0.80(mf) OTS
16998	17-2007	Dep.(mc); $6.60(fs); $2.09(mf) OTS
17000	17-1236	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17001	17-1237	Dep.(mc); $2.60(fs), $0.92(mf) OTS
17002	17-1238	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17003	17-1239	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17010	17-1240	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17013	17-1241	Dep.(mc); $1.10(fs), $0.80(mf) OTS
17027	17-2008	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17030	17-1391	Dep.(mc); $2.60(fs), $0.80(mf) OTS
17032	17-2479	Dep.(mc); $6.60(fs), $2.09(mf) OTS
17033	17-1421	Dep.(mc); $2.60(fs), $1.10(mf) OTS
17036	17-1627	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17044	17-1422	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17046	17-1527	Dep.(mc); $8.10(fs), $2.87(mf) OTS
17049	17-1608	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17050	17-2480	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17059	17-2340	Dep.(mc); $2.60(fs), $1.01(mf) OTS
17068	17-1172	To be published in TID-7638 Proceedings of the Symposium on Progress in Nuclear Education, held in Gatlinburg, Tennessee, August 20–22, 1962
17074	17-2365	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17083	17-2243	Dep.(mc); $4.60(fs), $1.52(mf) OTS
17091	17-1609	Dep.(mc); $2.60(fs), $0.89(mf) OTS
17173	17-2650	IAEA Preprint No. SM-31/6. To be published in IAEA Proceedings of the Symposium on the Treatment and Storage of High-Level Radioactive Wastes, held in Vienna, October 8–13, 1962
17174	17-1947	Dep.(mc); $2.60(fs), $1.10(mf) OTS
17175	17-2654	IAEA Preprint No. SM-31/10. To be published in IAEA Proceedings of the Symposium on the Treatment and Storage of High-Level Radioactive Wastes, held in Vienna, October 8–13, 1962
17176	17-2651	IAEA Preprint No. SM-31/18. To be published in IAEA Proceedings of the Symposium on the Treatment and Storage of High-Level Radioactive Wastes, held in Vienna, October 8–13, 1962
17177	17-2652	IAEA Preprint No. SM-31/17. To be published in IAEA Proceedings of the Symposium on the Treatment and Storage of High-Level Radioactive Wastes, held in Vienna, October 8–13, 1962
17178	17-1242	Dep.(mc); $4.60(fs), $1.49(mf) OTS
17180	17-2009	Dep.(mc); $4.60(fs), $1.43(mf) OTS
17182	17-1948	Dep.(mc); $4.60(fs), $1.55(mf) OTS
17183	17-2244	Dep.(mc); $2.60(fs), $0.92(mf) OTS
17185	17-2062	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17186	17-2341	Dep.(mc); $4.60(fs), $1.52(mf) OTS
17188	17-1361	Dep.(mc); $1.10(fs), $0.80(mf) OTS
17194	17-1710	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17195	17-2481	Dep.(mc); $1.10(fs), $0.80(mf) OTS
17196	17-2622	Dep.(mc); $1.10(fs), $0.80(mf) OTS
17199	17-2585	Dep.(mc); $2.60(fs), $1.01(mf) OTS
17205	17-2168	Phys. Rev. Letters, 9: 475-7(1962)
17206	17-1949	Dep.(mc); $4.60(fs), $1.55(mf) OTS
17207	17-2655	IAEA Preprint No. SM-31/11. To be published in IAEA Proceedings of the Symposium on the Treatment and Storage of High-Level Radioactive Wastes, held in Vienna, October 8–13, 1962
17209	17-2653	IAEA Preprint No. SM-31/7. To be published in IAEA Proceedings of the Symposium on the Treatment and Storage of High-Level Radioactive Wastes, held in Vienna, October 8–13, 1962
17210	17-2628	Dep.(mc); $2.60(fs), $1.07(mf) OTS
17213	17-1514	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17219	17-1528	Dep.(mc); $3.60(fs), $1.25(mf) OTS

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17220(Pt.1)	17-1876	Dep.(mc); $3.60(fs), $1.31(mf) OTS
17220(Pt.2)	17-1877	Dep.(mc); $3.60(fs), $1.31(mf) OTS
17227	17-2010	Dep.(mc); $4.60(fs), $1.55(mf) OTS
17260	17-1950	Dep.(mc); $12.50(fs), $5.36(mf) OTS
17276	17-1951	Dep.(mc); $8.10(fs), $2.84(mf) OTS
TM–	**(Misc.)**	
3362-67*	17-1887	See AD-273746
UAC–		
5551	17-1707	See TID-14021
5596	17-2060	See TID-14168
5905	17-1420	See TID-14906
6659	17-1749	See TID-16860
6664	17-2339	See TID-16867
6706	17-2481	See TID-17195
6711	17-2622	See TID-17196
6778	17-1514	See TID-17213
6787	17-1361	See TID-17188
6811	17-2062	See TID-17185
6814	17-1870	See ANL-FGF-381
6817	17-1871	See ANL-FGF-385
6821	17-2585	See TID-17199
UCLA–		
496	17-1233	Soil Sci. 94: 187-97(1962)
UCOL-P–		
513	17-2244	See TID-17183
UCRL–		
5947-T	17-2063	Dep.(mc); $1.10(fs), $0.80(mf) OTS
6431	17-1899	Dep.(mc); $7.60(fs), $2.36(mf) OTS
6611	17-2448	J. Math. Phys. 3: 1003-16(1962)
6863	17-2586	Dep.; $1.50(OTS)
6959-T	17-2421	Dep.(mc); $1.10(fs), $0.80(mf) OTS
6980	17-2159	Dep.; $0.50(OTS)
6997	17-1818	Dep.; $0.50(OTS)
7028	17-1952	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7032	17-2245	Dep.; $0.50(OTS)
7036(Pt.8)	17-2587	Dep.(mc); $3.60(fs), $1.16(mf) OTS
9787	17-1582	Dep.; $2.00(OTS)
10121	17-2383	J. Nucl. Energy, Pt. C, 337-40(1962)
10187	17-2169	Dep.; $2.00(OTS)
10205	17-2170	Dep.; $1.25(OTS)
10280	17-1750	Dep.(mc); $1.60(fs), $0.80(mf) OTS
10429	17-2246	Dep.; $2.00(OTS)
10439	17-2416	Dep.(mc); $3.60(fs), $1.25(mf) OTS
10441	17-1953	Dep.(mc); $2.60(fs), $0.98(mf) OTS
10457	17-1954	Dep.; $1.75(OTS)
10490	17-1955	Dep.(mc); $1.60(fs), $0.80(mf) OTS
13004	17-1634	Dep.(mc); $2.60(fs), $0.92(mf) OTS
13048	17-2643	Dep.(mc); $5.60(fs), $1.73(mf) OTS
UCRL-Trans–		
258	17-2249	Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS
854(L)	17-1424	Dep.(mc); $1.60(fs), $0.80(mf) JCL or OTS
856(L)	17-2069	Dep.(mc); $3.60(fs), $1.37(mf) JCL or OTS
869(L)	17-2368	Dep.(mc); $1.60(fs), $0.80(mf) JCL or OTS
874(L)	17-2070	Dep.(mc); $1.10(fs), $0.80(mf) JCL
UMC-D–		
62-218	17-2007	See TID-16998
USNRDL-TR–	**(Misc.)**	
577*	17-2011	$16.00(fs) OTS
580*	17-1751	$2.60(fs) OTS
588*	17-1566	$1.60(fs) OTS
UVA–		
269-62U	17-1583	Dep.(mc); $1.60(fs), $0.80(mf) OTS
VDIT–	**(Swedish)**	
16(2.2)	17-2012	Dep.(mc)
WADC-TR–	**(Misc.)**	
54-276*	17-1956	$15.30(fs), $5.40(mf) OTS
WAPD-TM–	**(Misc.)**	
325	17-1957	Dep.; $0.75(OTS)
WCAP–	**(Misc.)**	
1900(Add.)	17-1711	Dep.(mc); $1.10(fs), $0.80(mf) OTS
6052	17-2588	Dep.; $2.00(OTS)
ZFK-TPH–	**(German)**	
3	17-2207	Dep.(mc)